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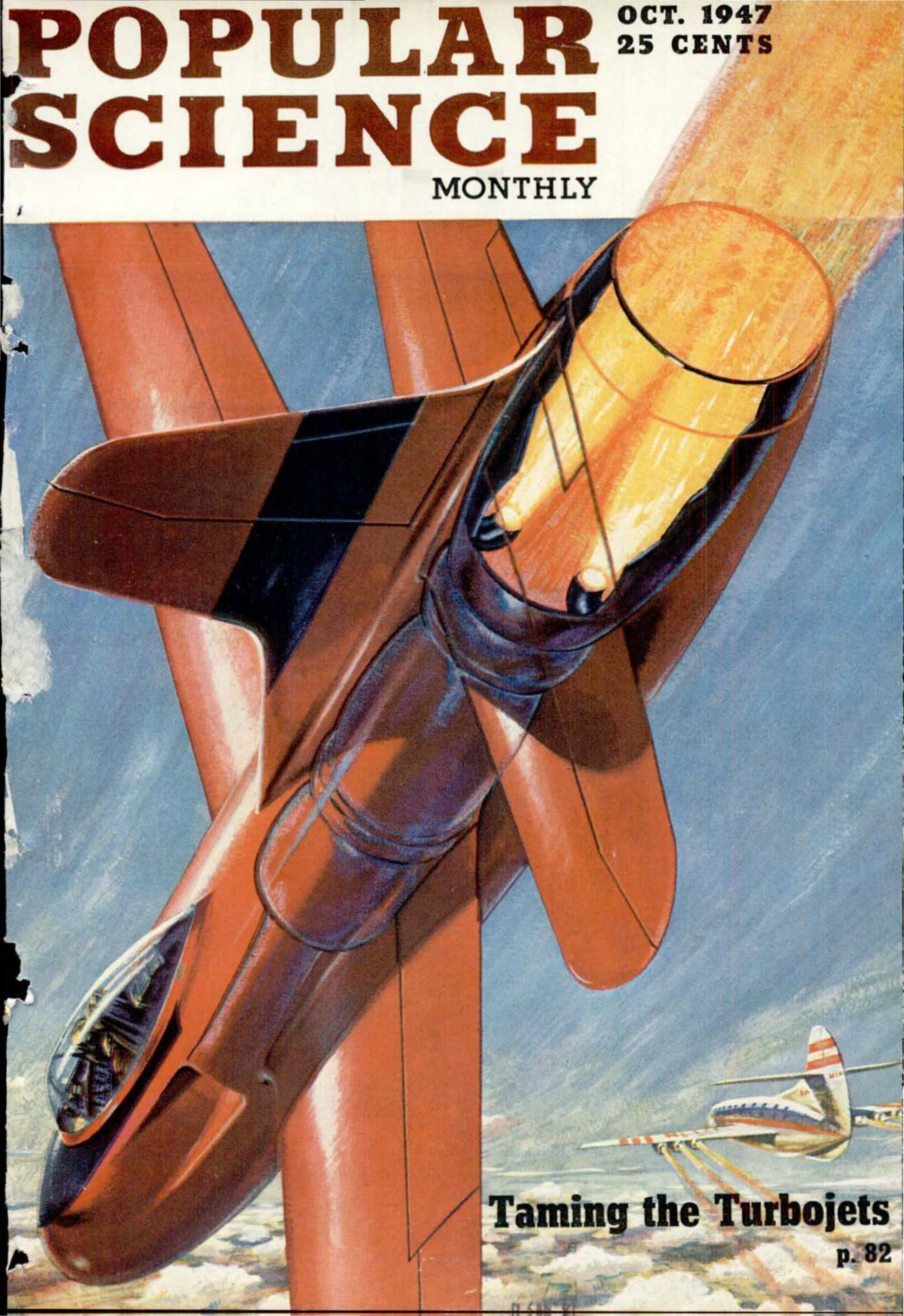

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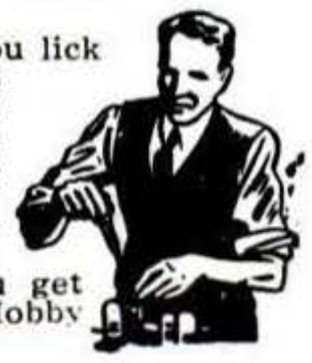

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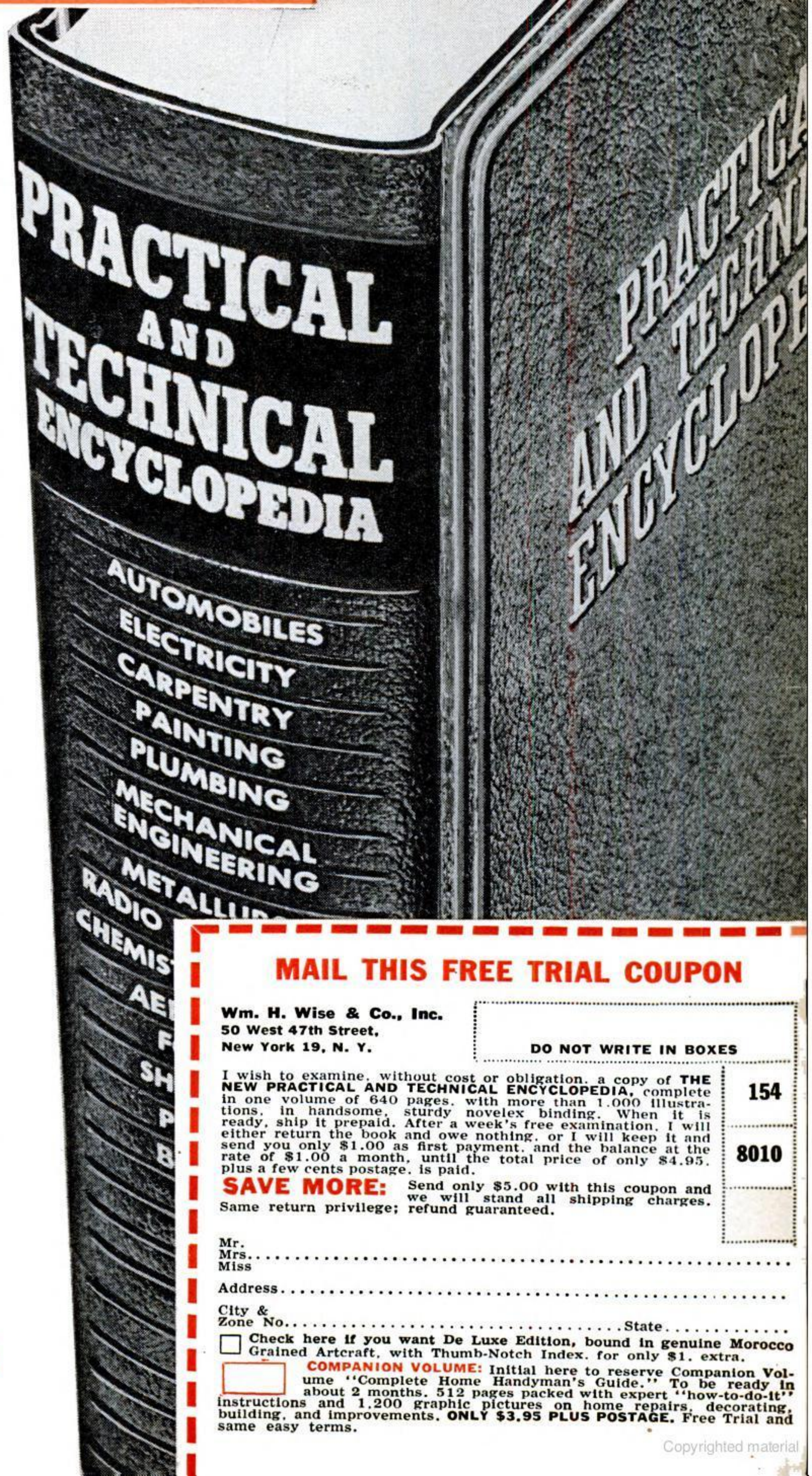

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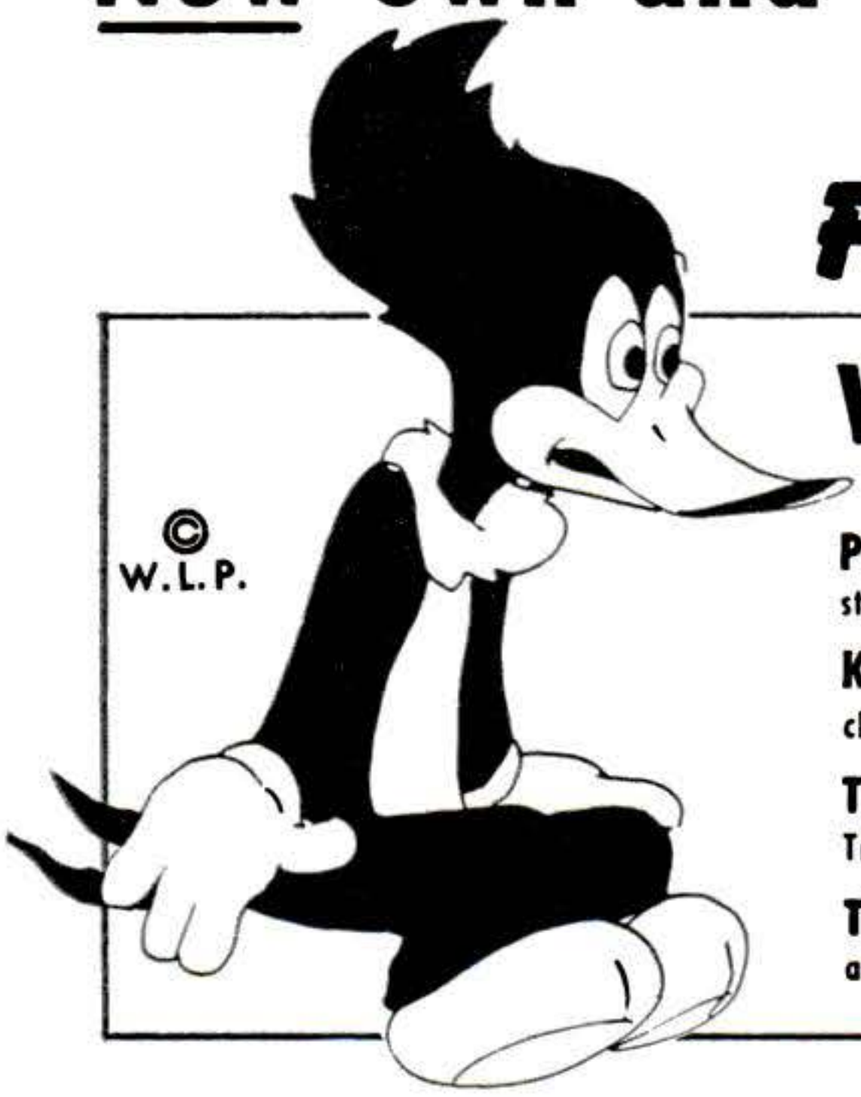

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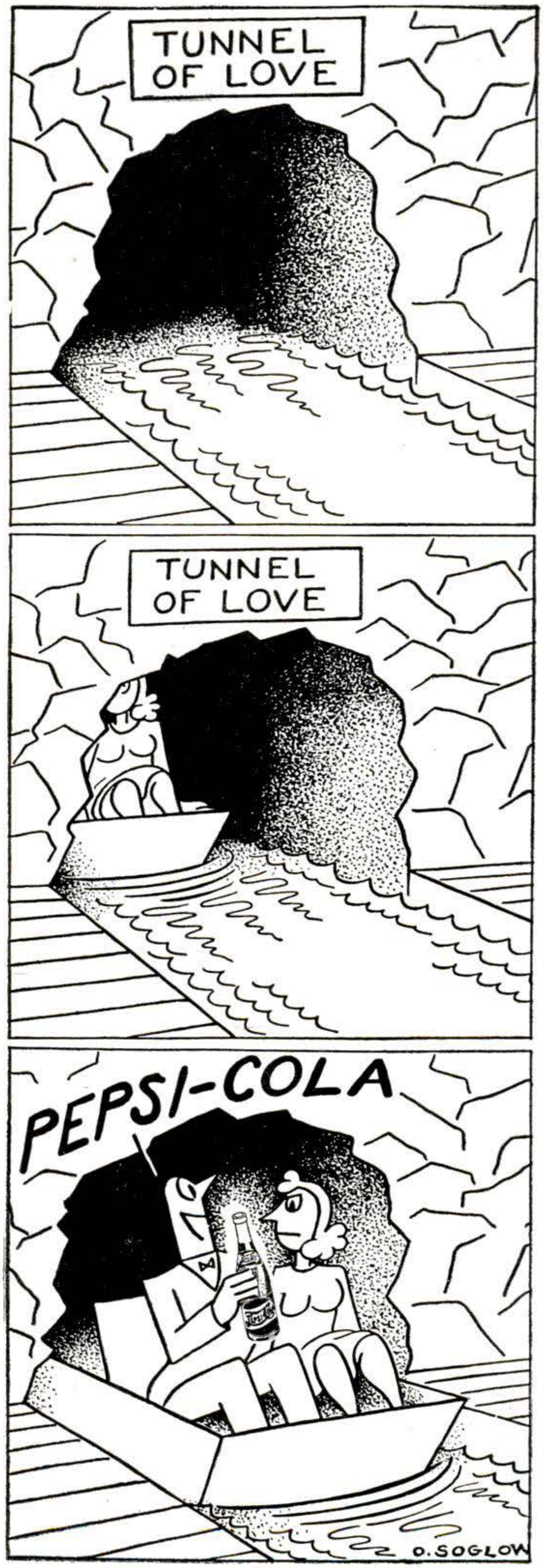

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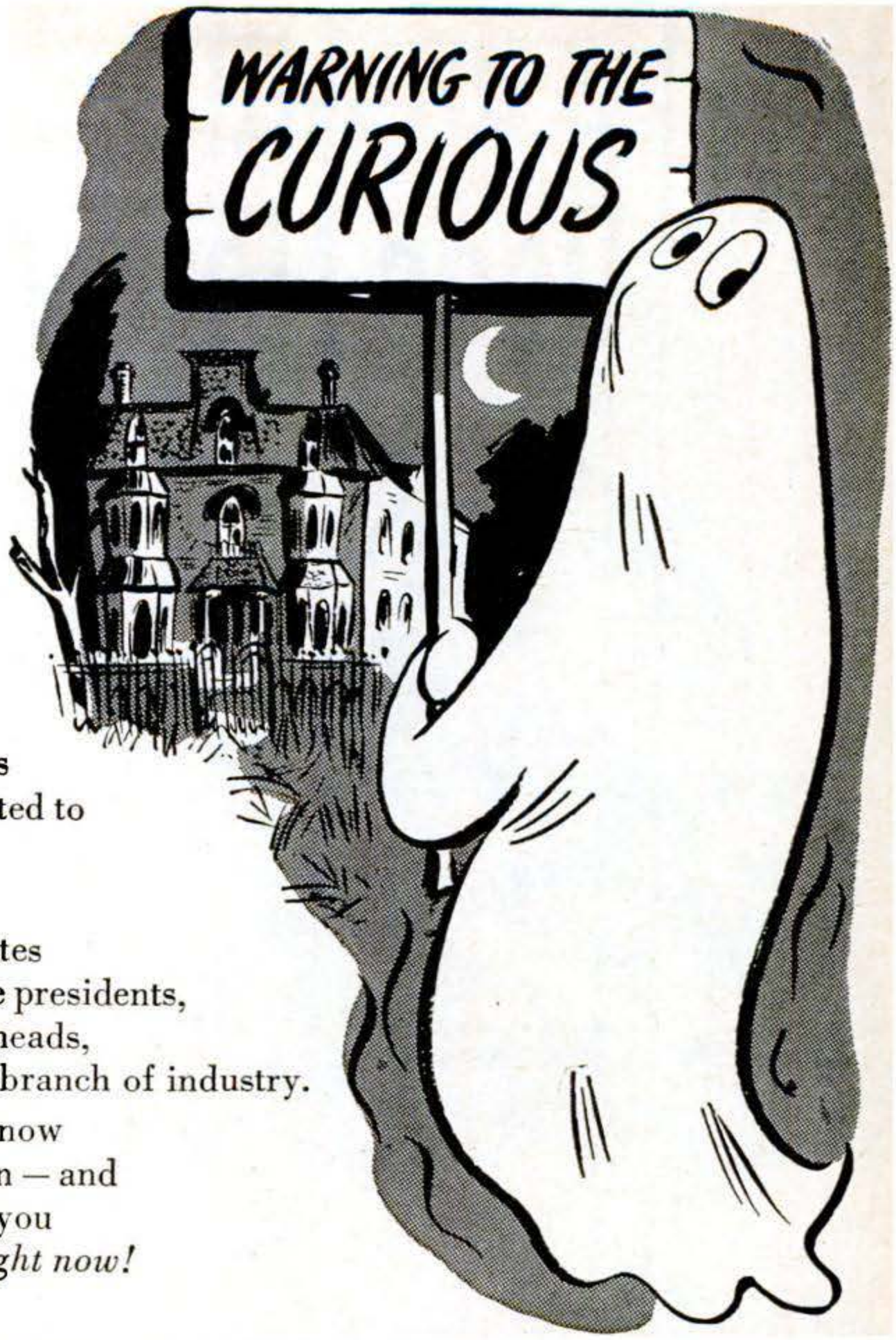

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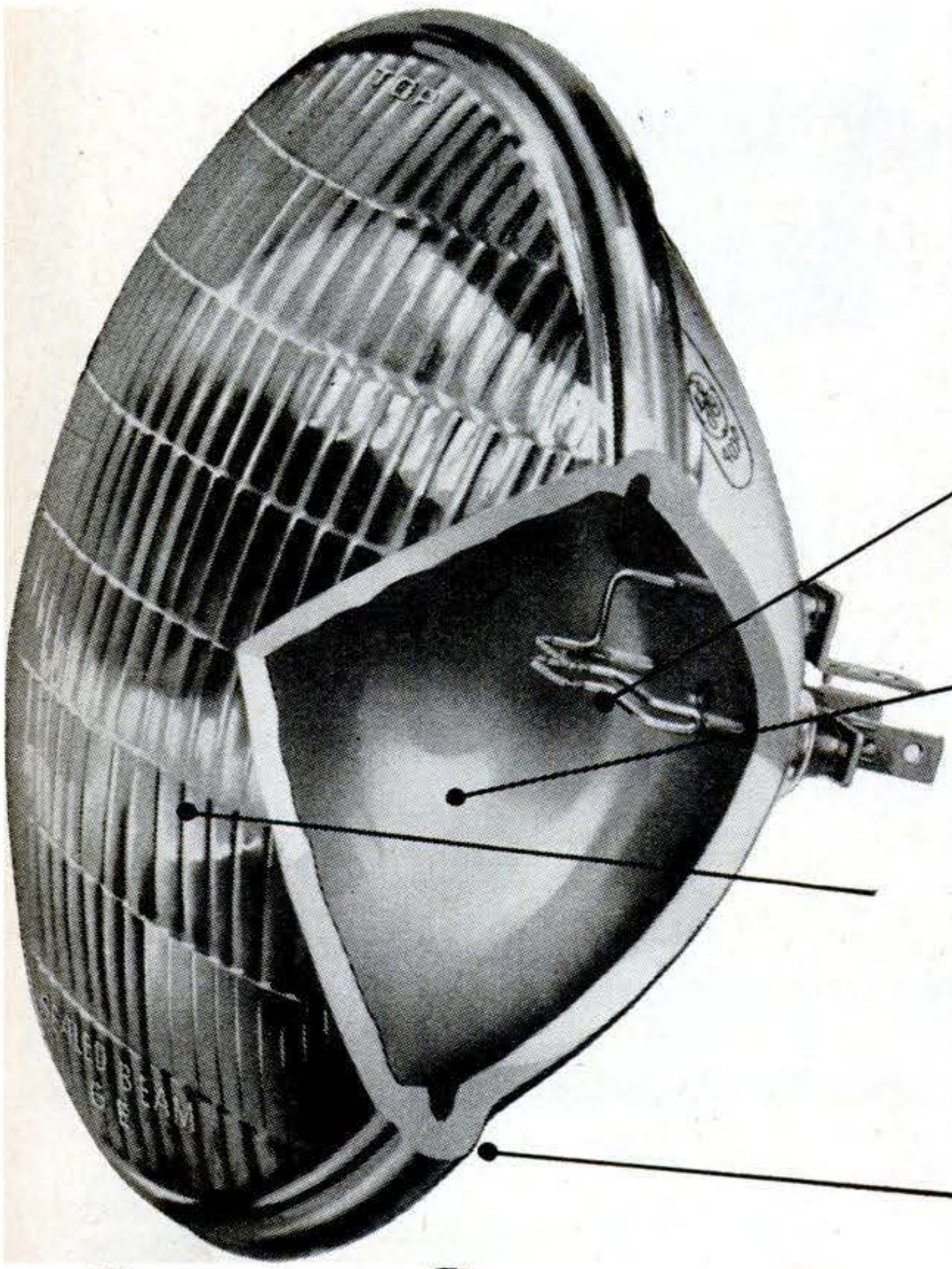

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A decade, or even a year ago, these crashes of aircraft groping for a landing could be blamed on the weather. This winter, these dead passengers and pilots will be the victims of vicious apathy in Congress, and sorry, stubborn pride in the Civil Aeronautics Administration.

As every reader of this magazine knows, science has long since done its part in the problem of getting airplanes downstairs in dirty winter weather. Radar, in the GCA (Ground Control Approach) System has made possible thousands of landings by military aircraft under the worst conditions with only a single failure.

But the CAA, stubbornly sticking to its chosen ILS (Instrument Landing System) wearied Congress to the point where it stopped listening—and slammed the safe door. So, this winter, there is not enough money for the installation of the kind of landing aids that safety demands.

Science showed the way; technology developed the equipment. But politics has halted the application of science to life in this case.

Perry Gilkeys

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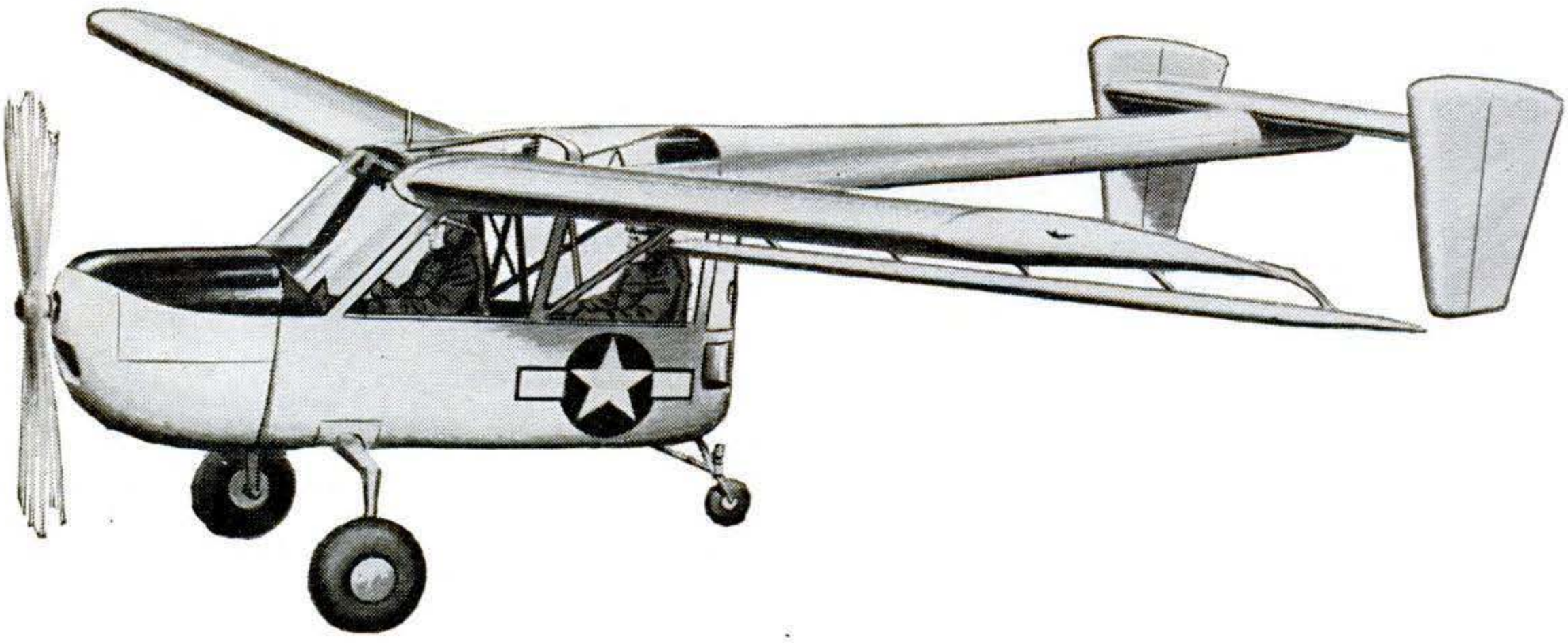

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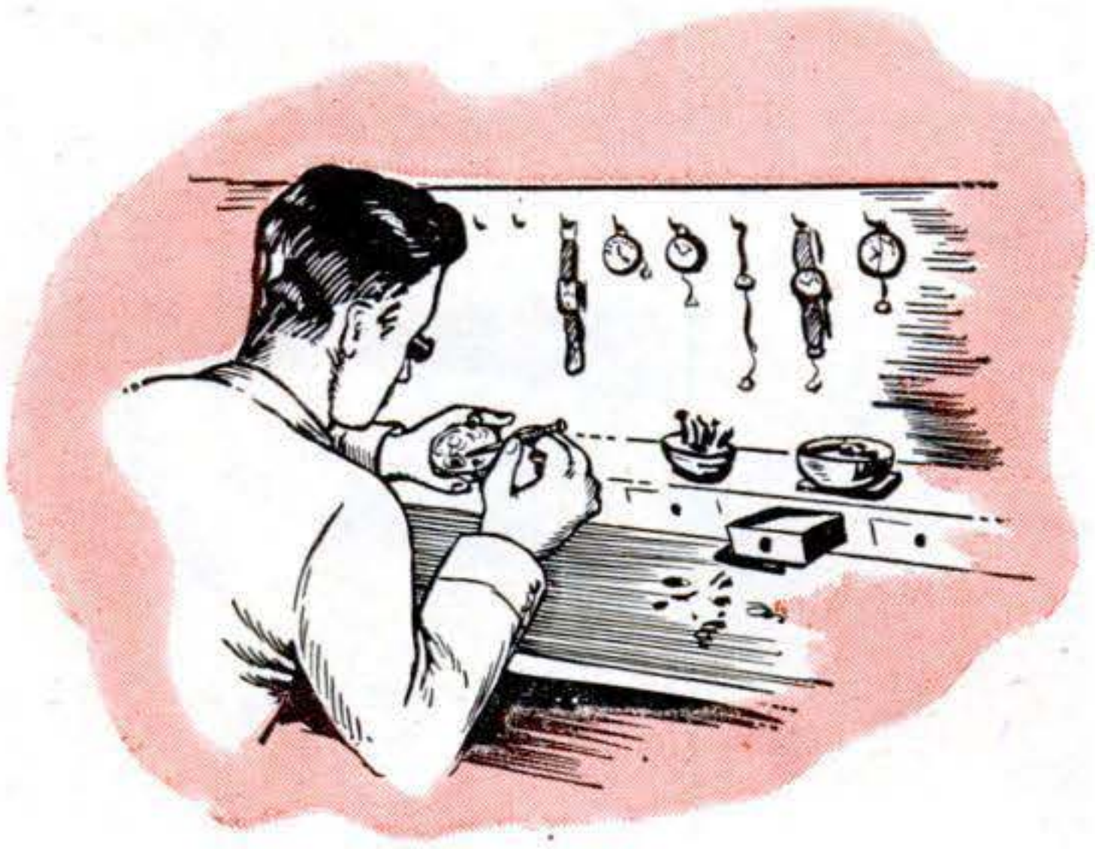

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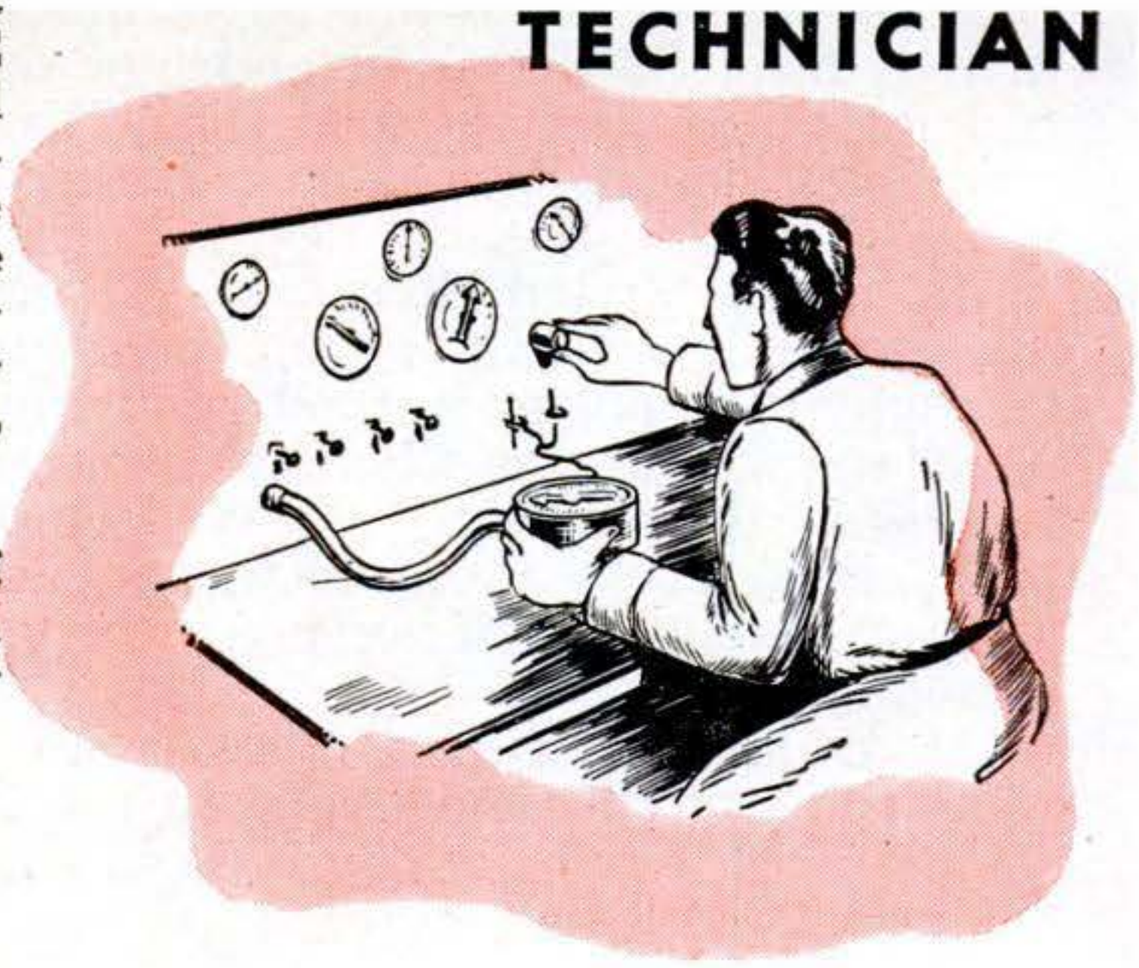

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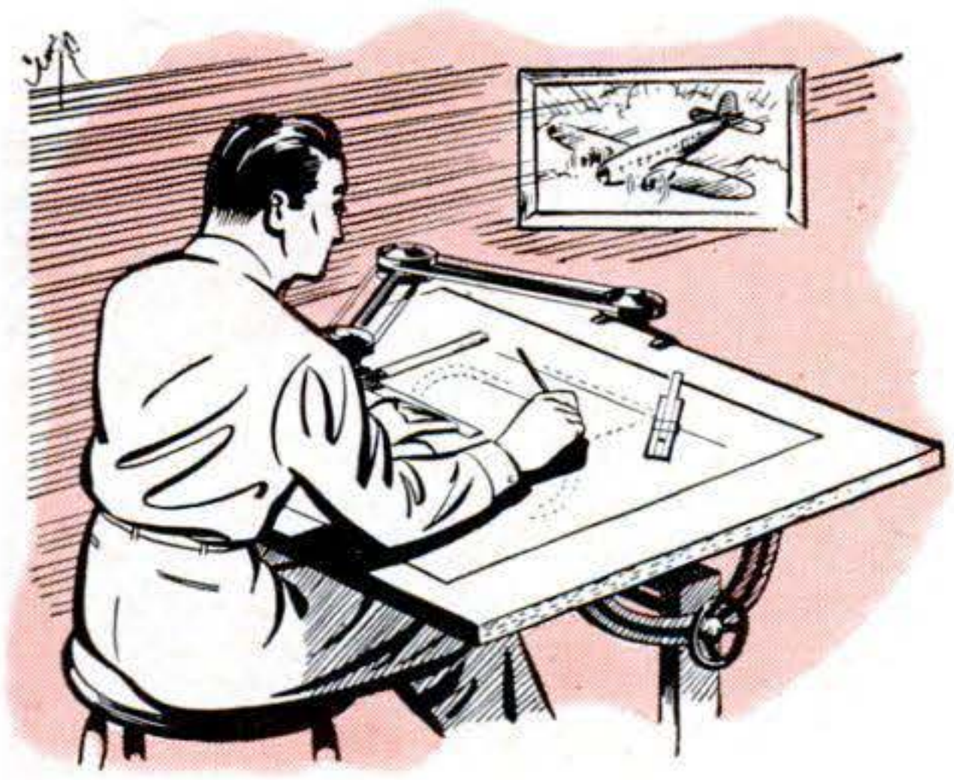

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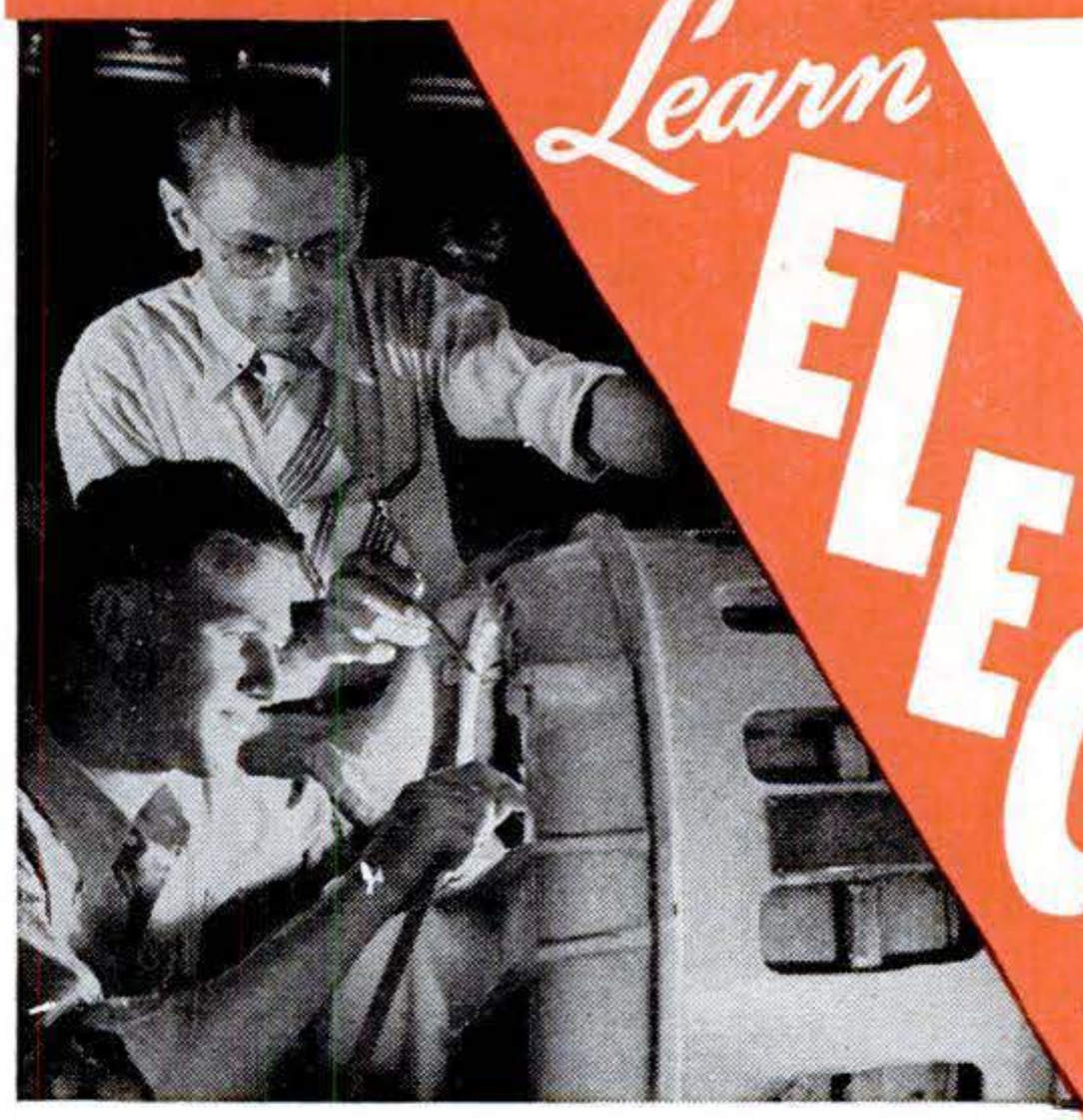

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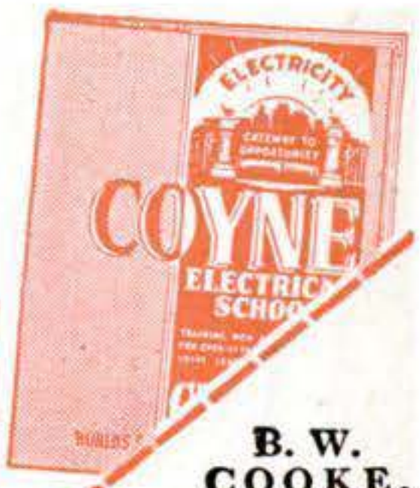

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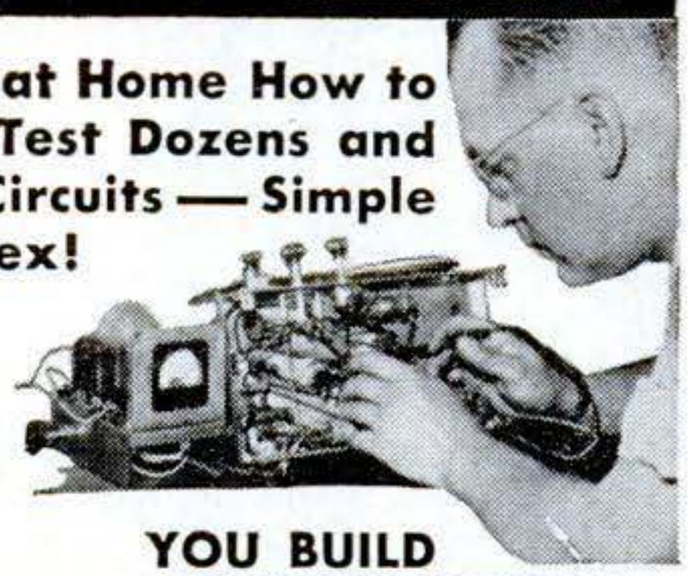

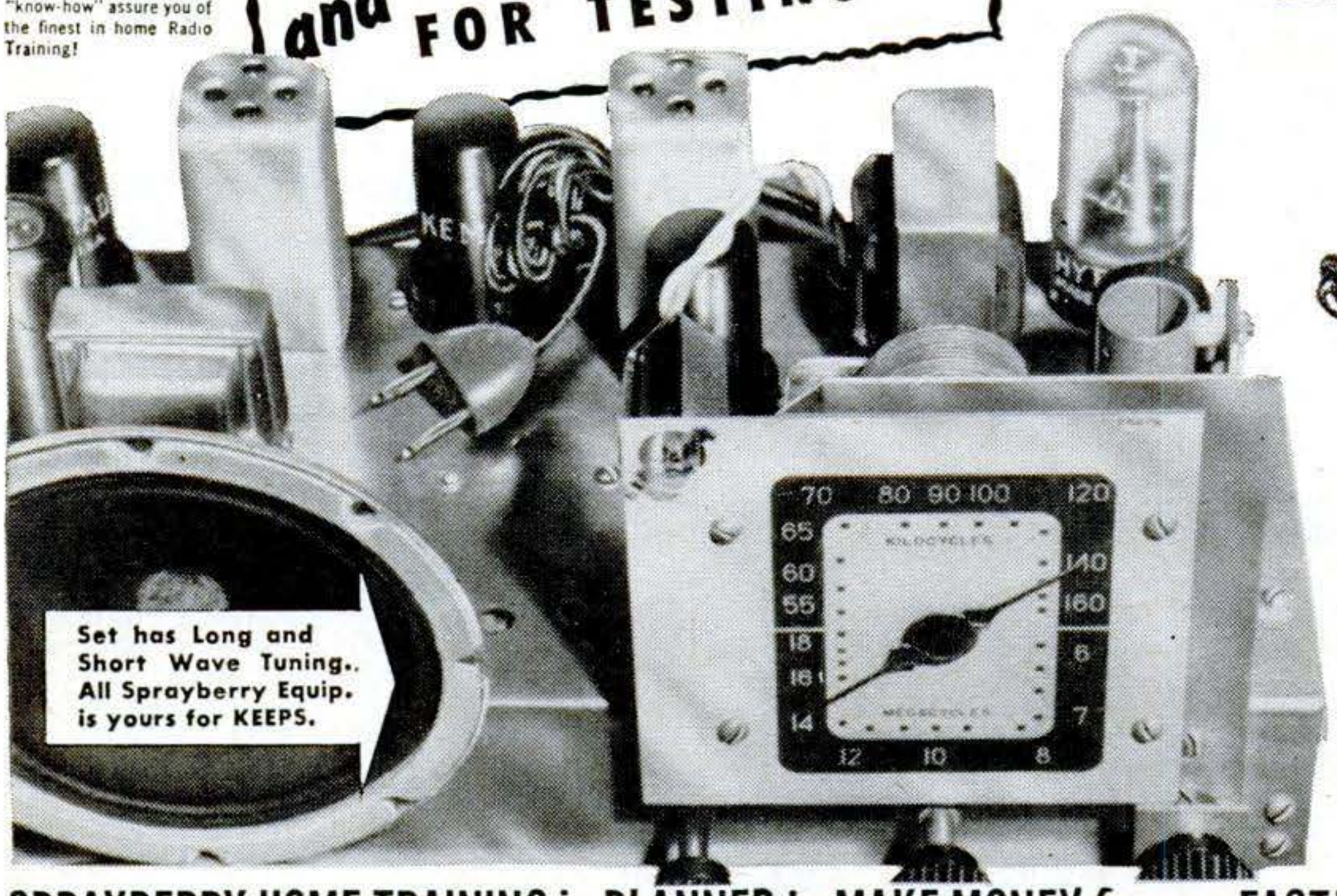

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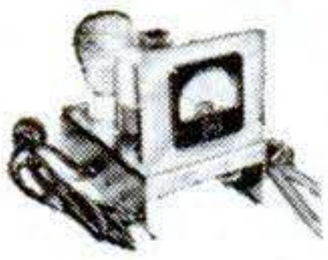
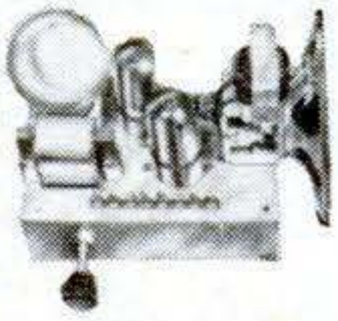


I give you a fine, moving-coil type Meter Instrument on Jewel Bearings — with parts for a complete Analyzer Circuit Continuity Tester. You learn how to check and correct Receiver defects with professional speed and accuracy.



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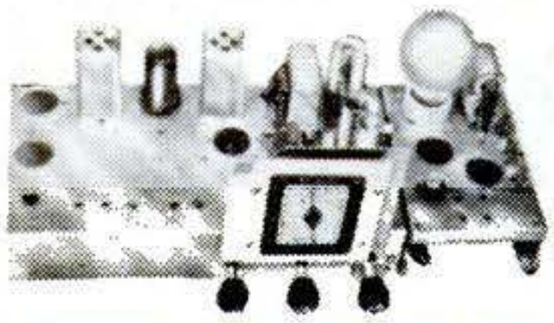

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LETTERS

Putting Color to Work

Sir:

I found Lloyd Stouffer's article "Color Punches the Time Clock" (PSM, June '47, p. 124) interesting.

However, in actual practice I have found confusion exists because the various paint manufacturers, together with such organizations as the National Safety Council and the American Standards Association, are not in agreement as to standardized color schemes for painting machinery. . . .

W. H. Boyer

York, Pa.

For further information on this subject, PSM consulted Lloyd Stouffer, author of the article. His answer:

Sir:

There is certainly no confusion among responsible authorities as to the application of industrial color. . . .

There can be no standard color scheme for better seeing because the requirements vary according to the type of work being done, the material being worked upon, and the type of natural and artificial light available. . . .

As to safety color markings, however, the American Standards Association code is the standard. The code recommended by Du Pont and other engineers and paint companies agrees with this but suggests that red be restricted to fire precautions and adds orange for danger and blue for precaution signals to mark electrical controls and equipment under repair.

Lloyd Stouffer

Old Greenwich, Conn.

Different, but the Same

Sir:

On page 104 of the August issue you have two pictures of McDonnell aircraft, and at first glance the two planes on the ground

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INVENTORS

Patent Laws Encourage The Development Of Inventions

The Rules of Practice of the U. S. Patent Office advises—unless an inventor is familiar with such matters—that he employ a competent registered attorney or registered agent, as the value of patents depends largely upon the skillful preparation of the specifications and claims.

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If an inventor believes he has an invention, a search of the most pertinent prior U. S. patents should be made and a report obtained relative to its patentability. Where such report indicates that the invention appears patentable, in order to secure protection, diligence should be exercised in making application for a patent.

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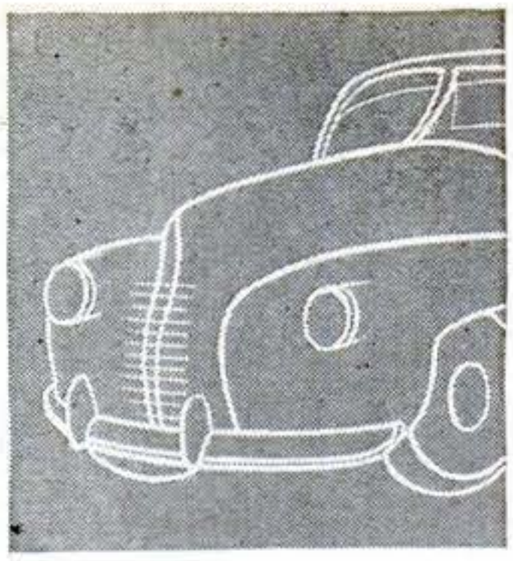

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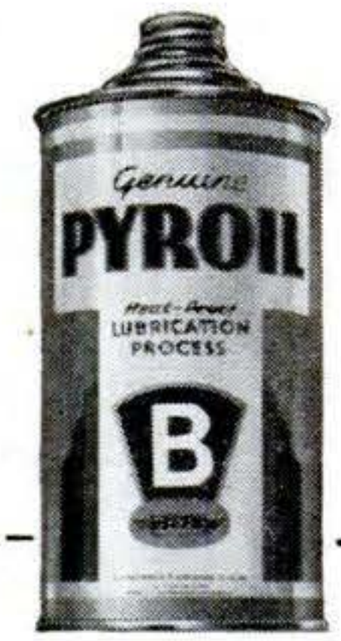

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Jerry, the talking dog, is entertaining hospitalized veterans, by courtesy of the PYROIL Company. Picture of Jerry sent on request.

appear to be the same. But the top plane seems to be the XF2D-1 Banshee and the lower the FD-1 Phantom. Note the difference in the tail shapes. . . .

ROBERT DUDLEY

Wichita Falls, Tex.

Though not identical, both planes are Phantoms. The upper one is the FD-1, the production model, while the lower is the XFD-1, an experimental version of the same plane before it had undergone slight tail and dihedral modifications.

Shocking Words?

Sir:

. . . I have several times been shocked by electricity, hard enough for things to turn hazy before I let loose. It got me to wondering if "words" could be transmitted by shocking on a lesser scale. A microphone or radio and amplifier could be hooked up and the output superimposed on a direct current with just enough voltage to be felt but not be uncomfortable. I have noticed that 60-cycle stuff has a rippling feeling. Different frequencies and voltages might be felt and "understood" by an experienced person. If it would work it would be welcomed by deaf and blind people. . . .

FLOYD D. DILL

La Verne, Calif.

It Sometimes Happens

Sir:

On January 6, 1947, I submitted an idea regarding the use of a lock-grip wrench as a nutcracker. On January 17, it was returned with a rejection slip. . . .

I was indeed surprised to find this idea appear at the bottom of page 158 in your July 1947 issue with a photograph—I did not submit a photograph—showing exactly the make of wrench that I mentioned . . . .

LT. CMDR. R. R. BREWIN, USNR

DeLand, Fla.

Lt. Cmdr. Brewin's idea was returned because it was not illustrated (a condition that often compels PSM to pass up otherwise good material) and the same idea was later submitted by another contributor. Such duplications are unfortunate, but fairly common—as every editor has to explain at some time in his career.

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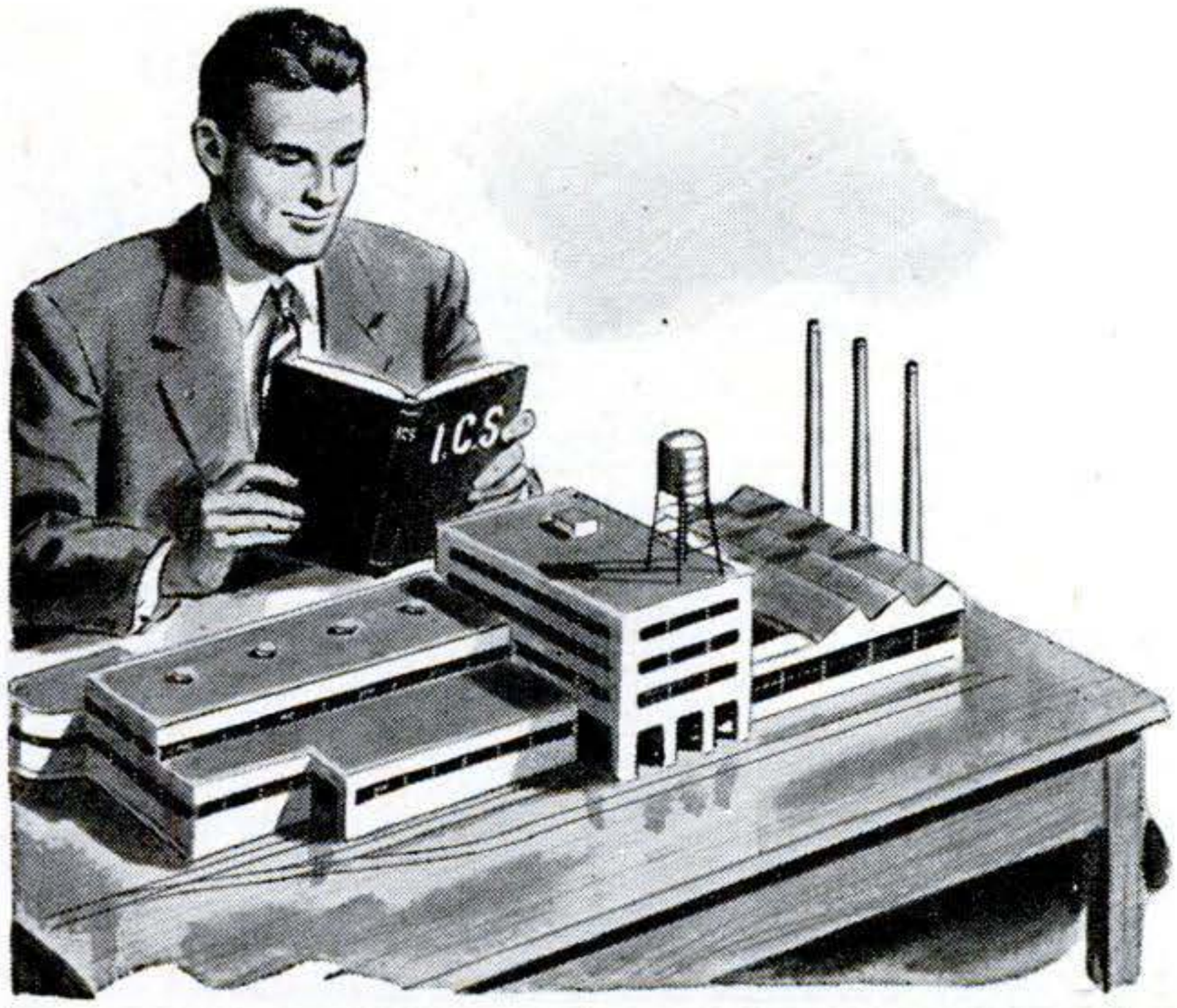
INDUSTRY

GROWS ON TABLE-TOPS



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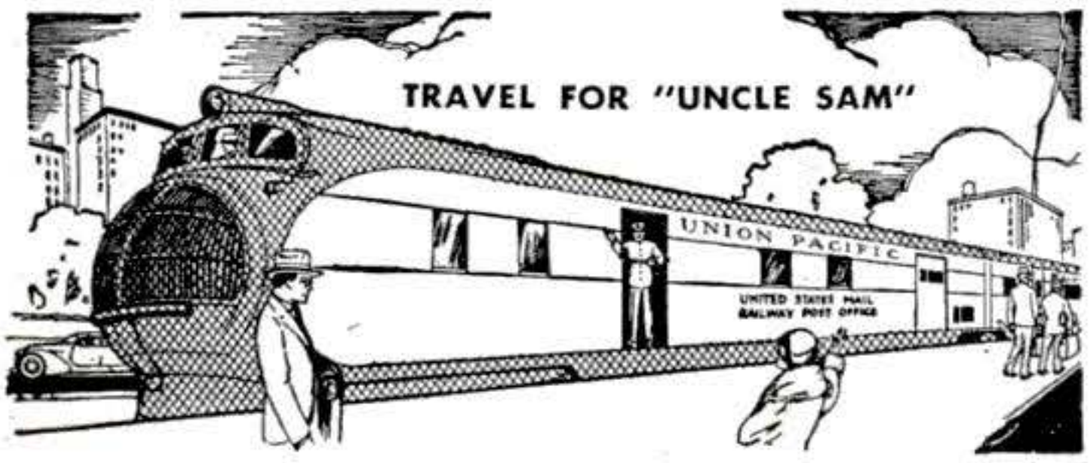

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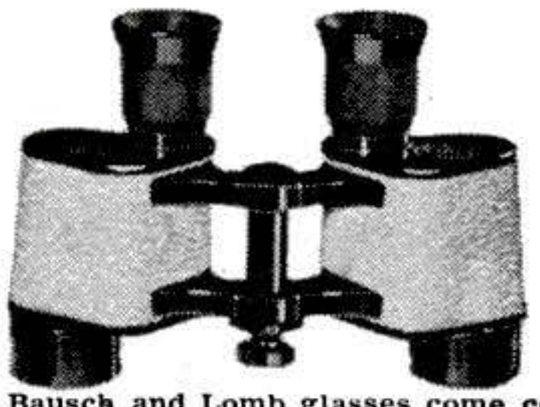

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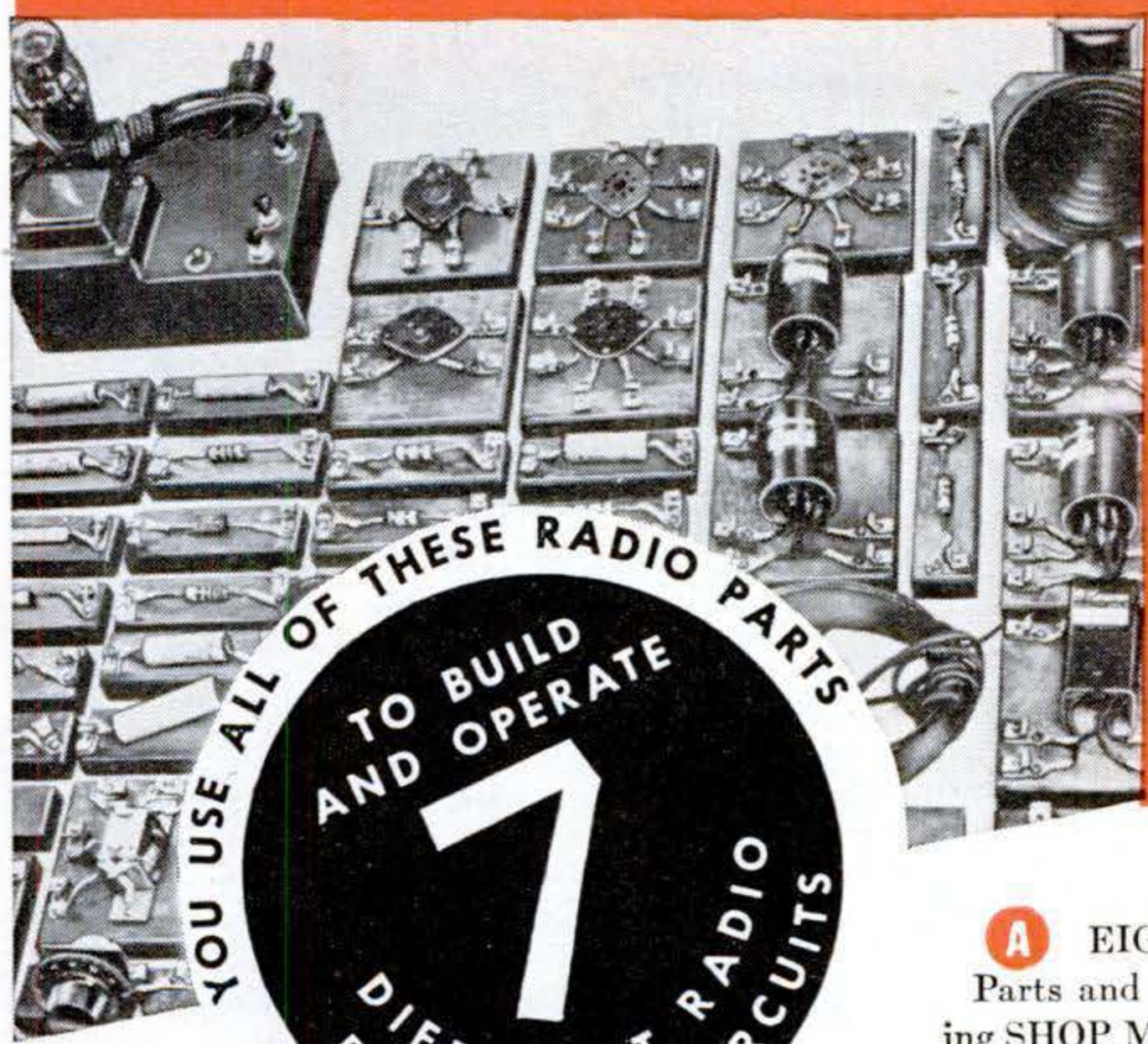

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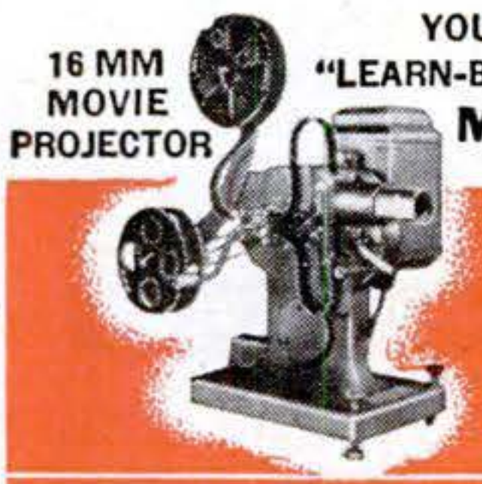

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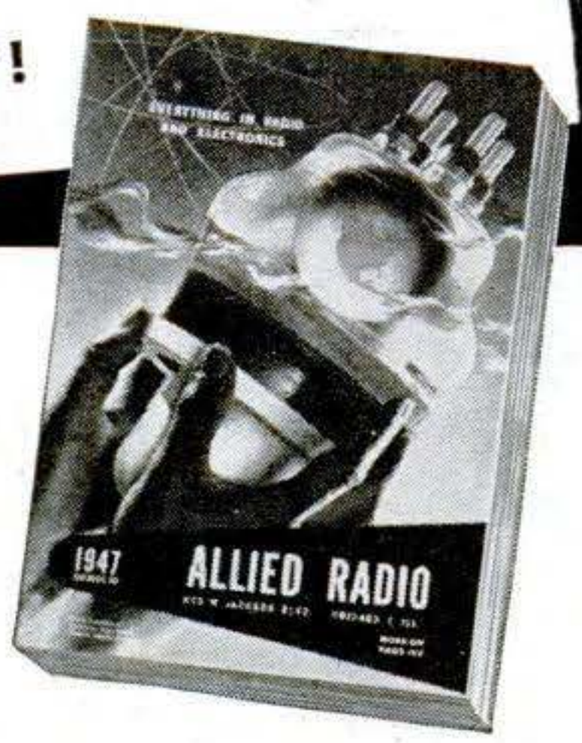

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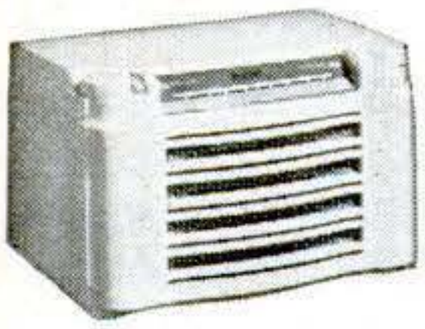

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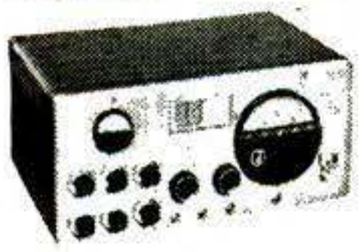

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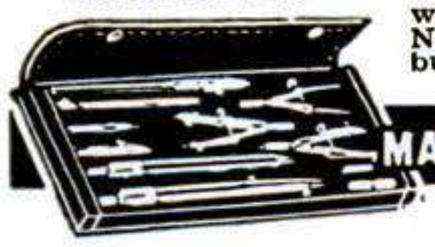

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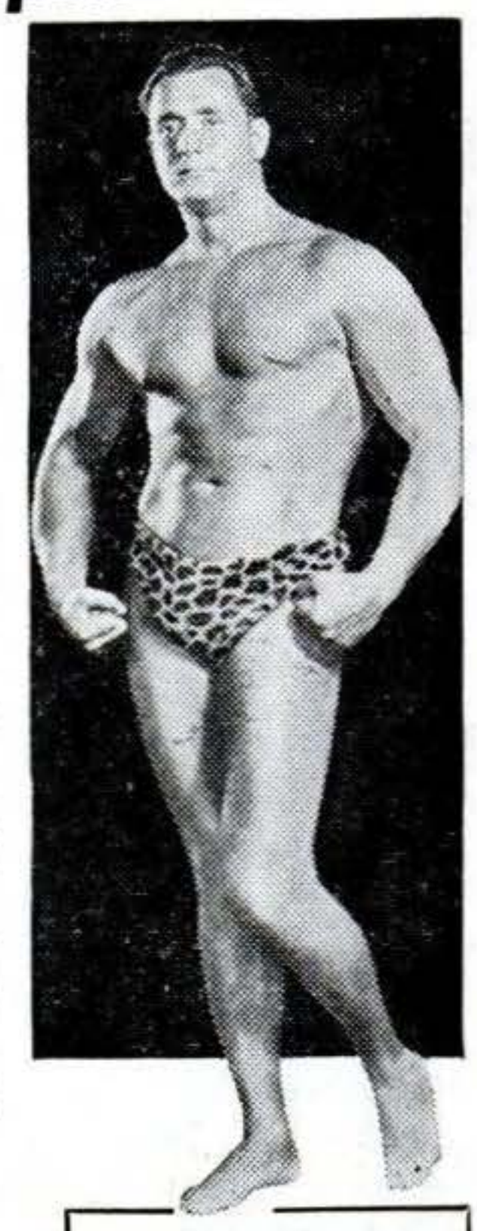

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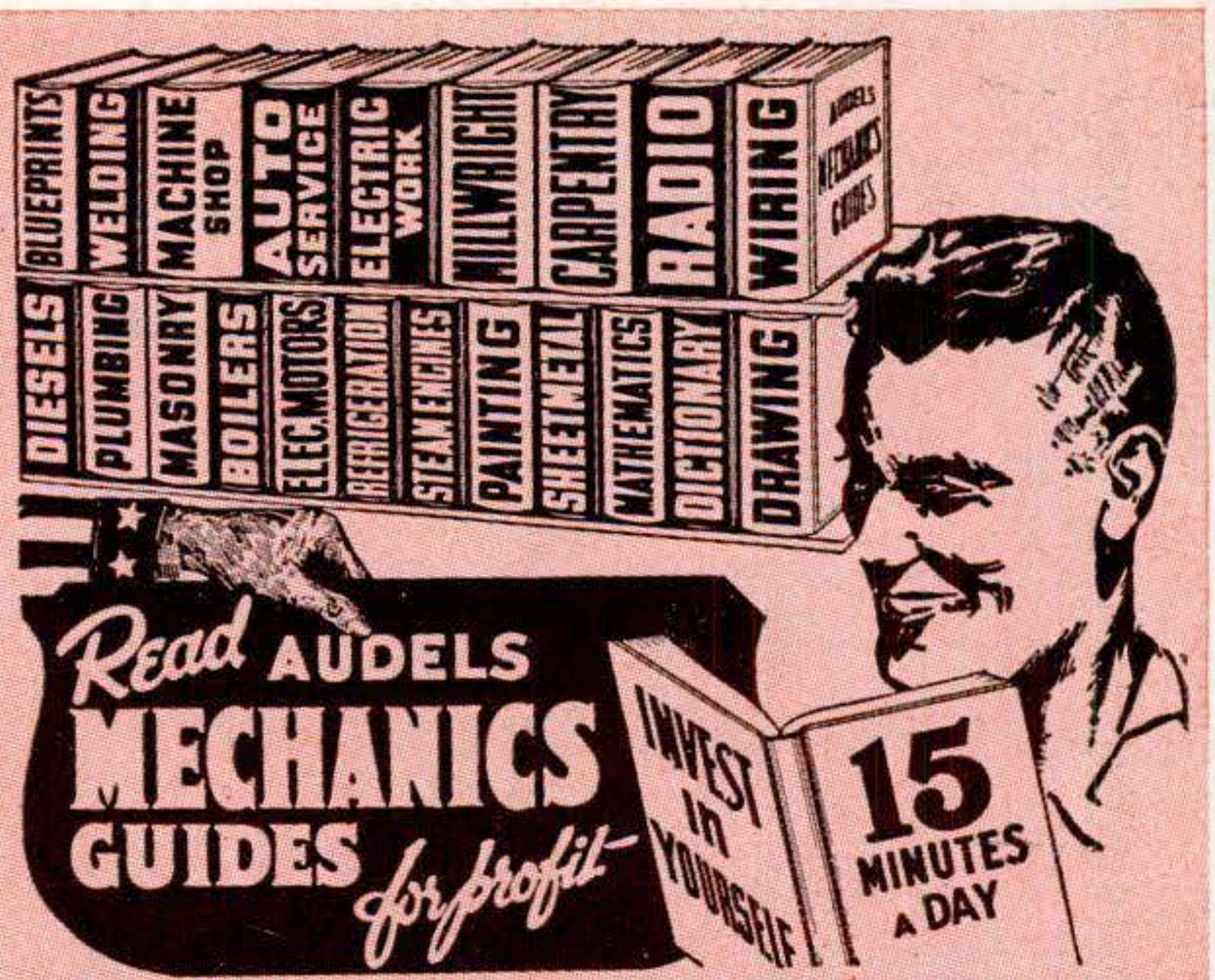

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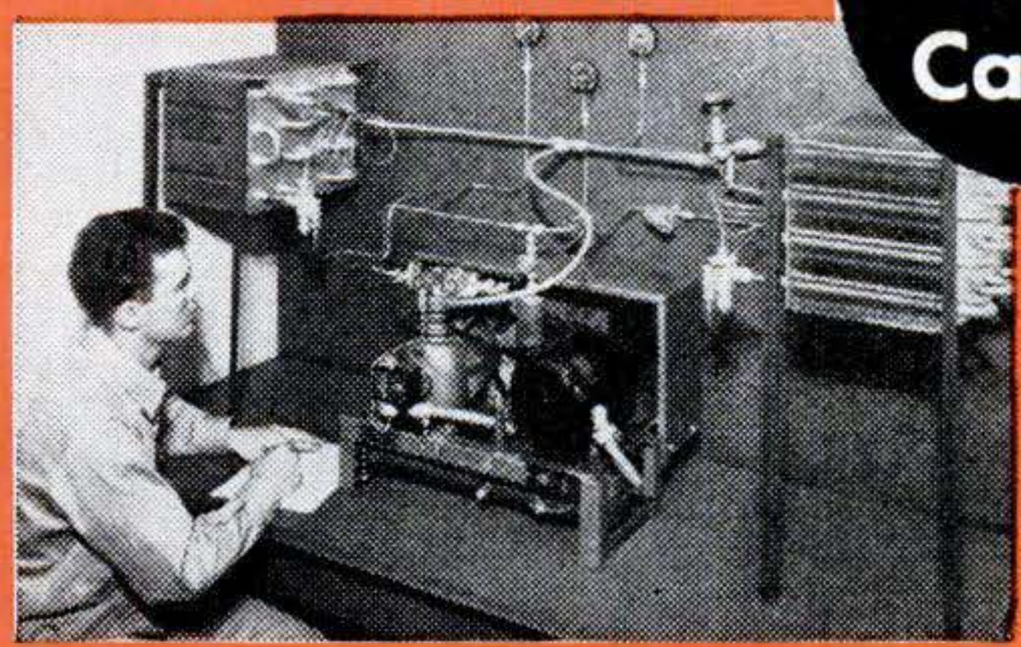

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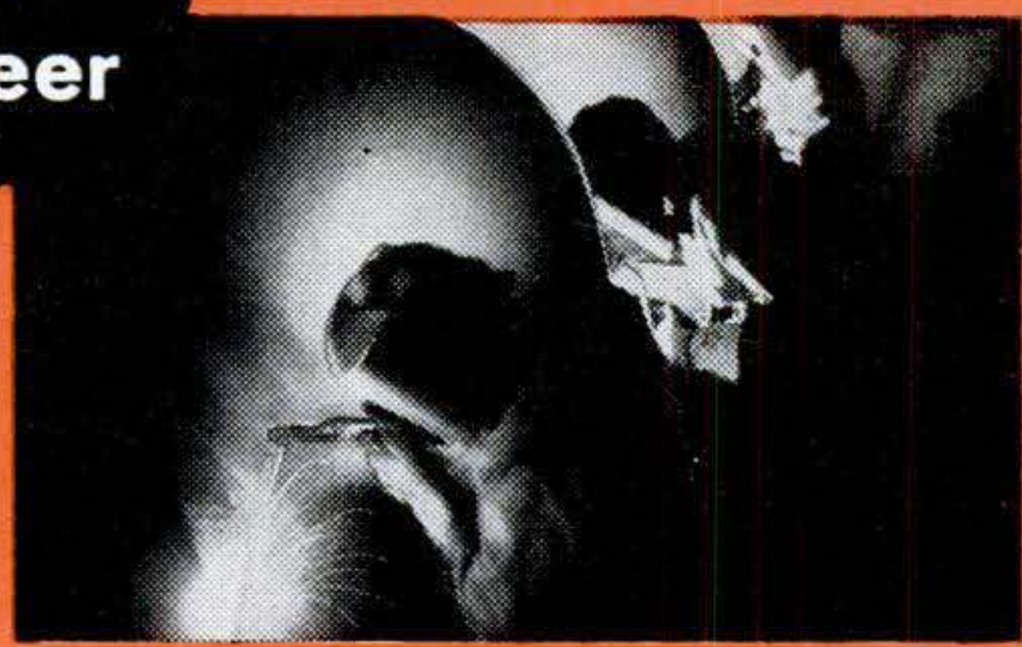

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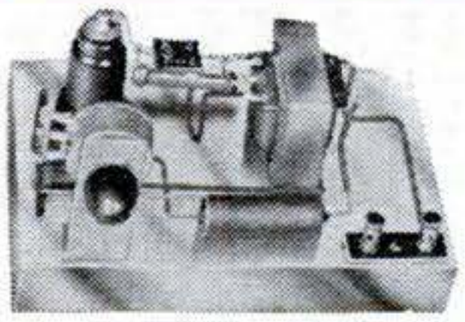

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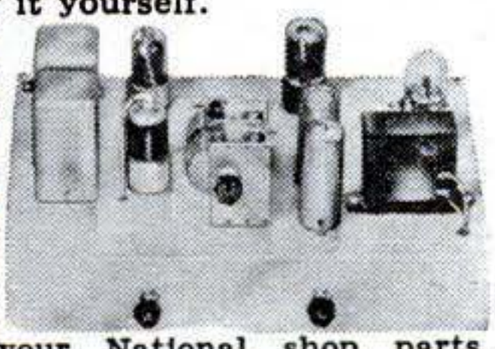

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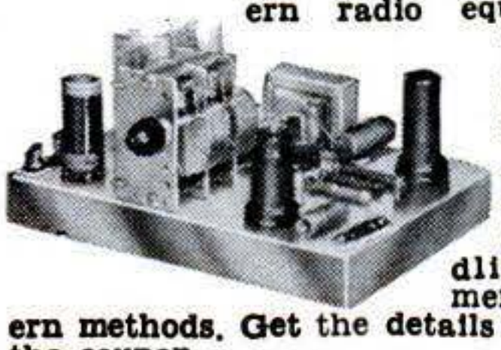

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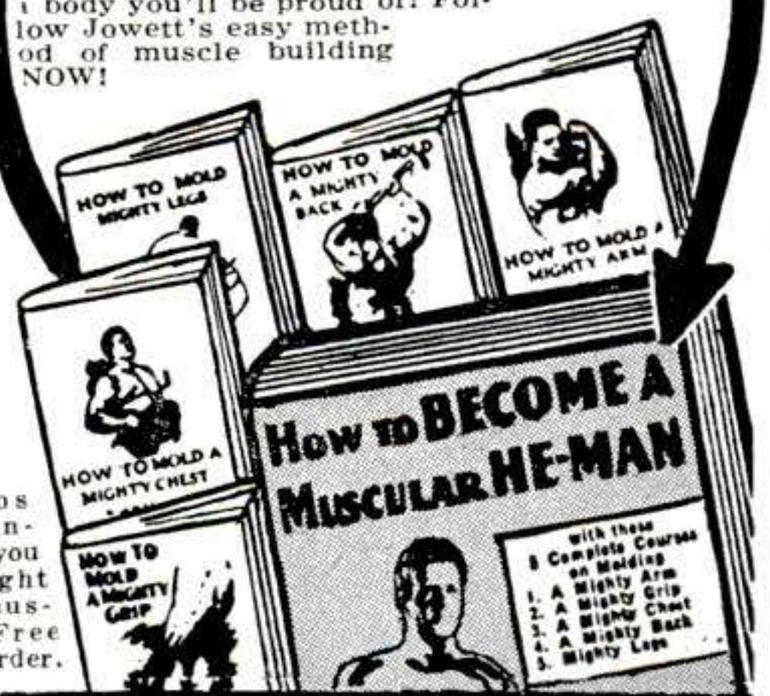

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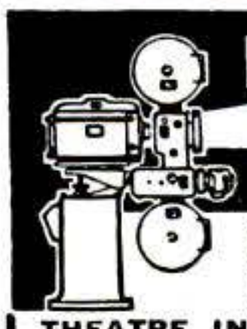

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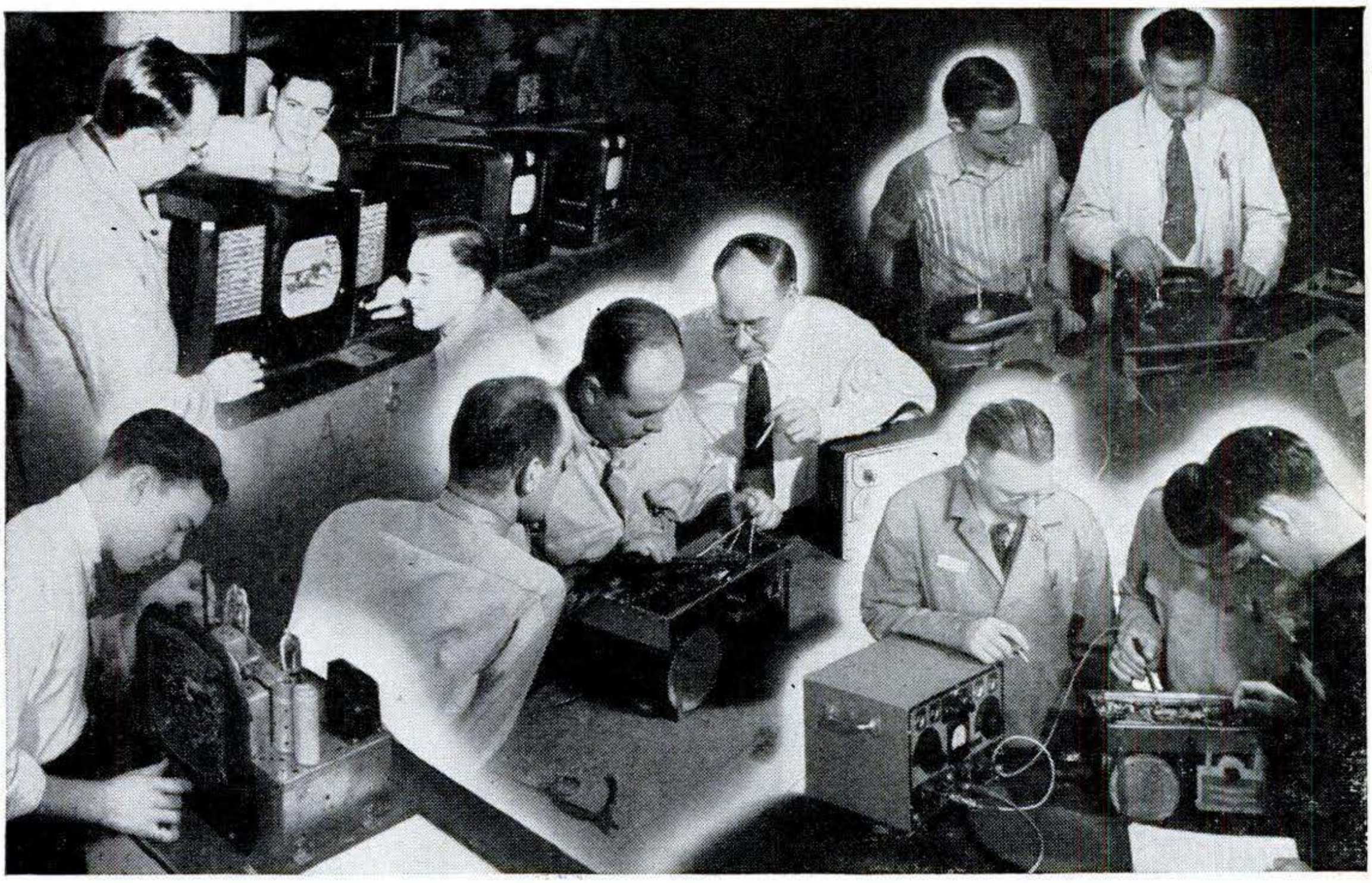

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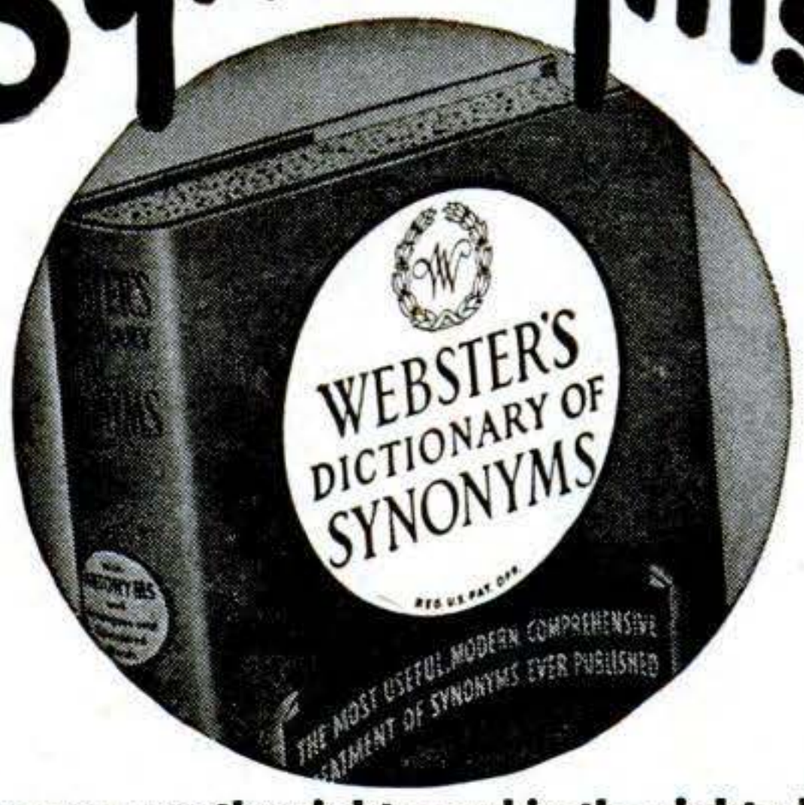

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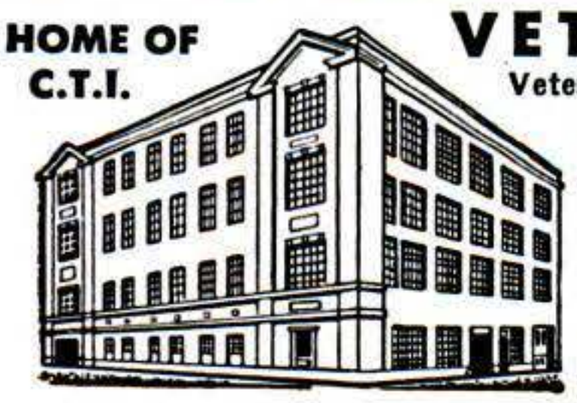

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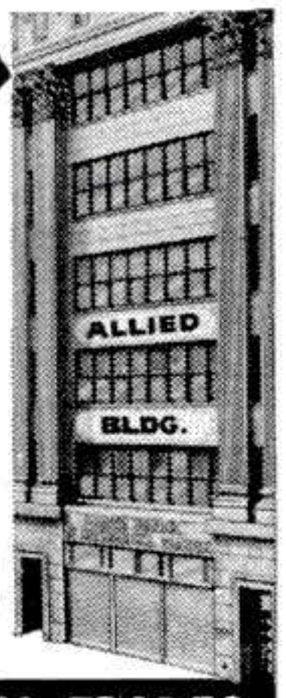

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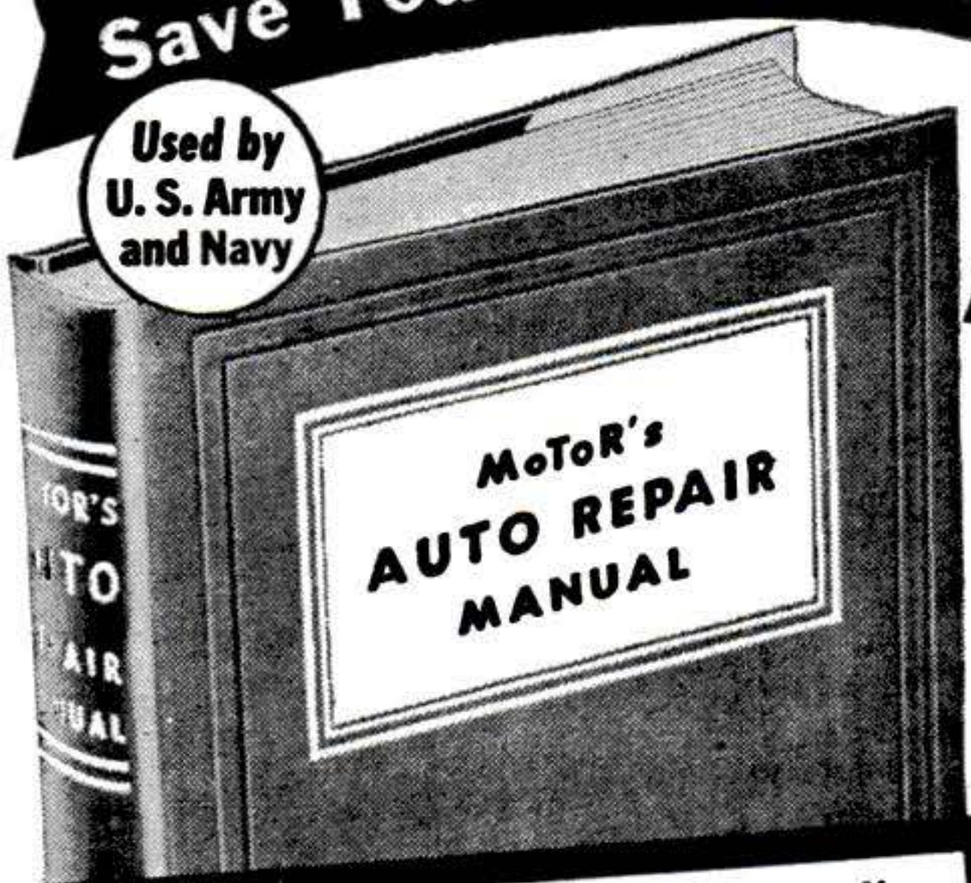

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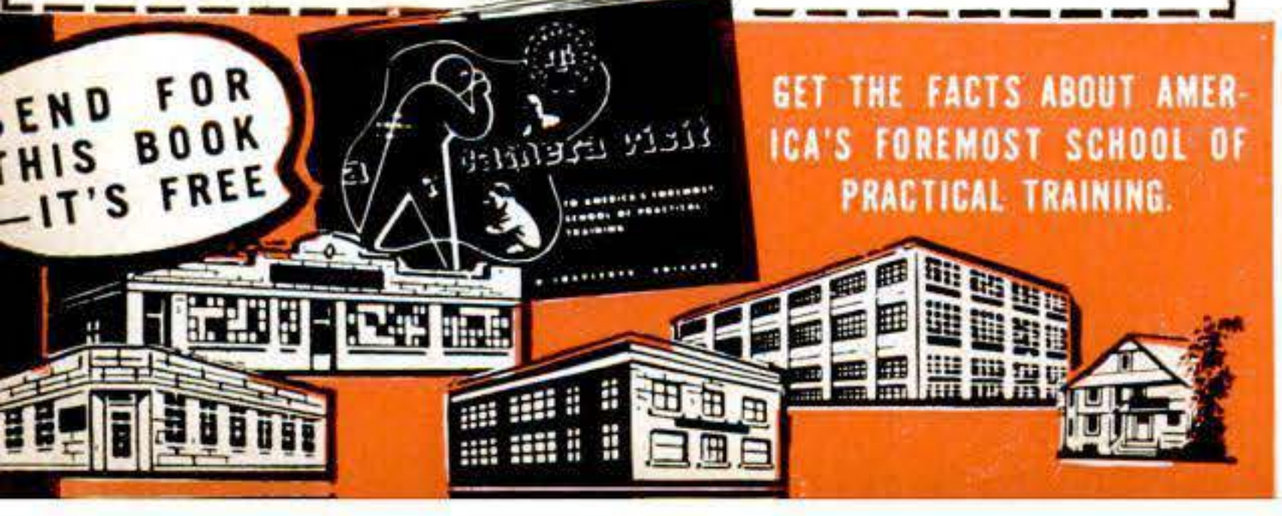

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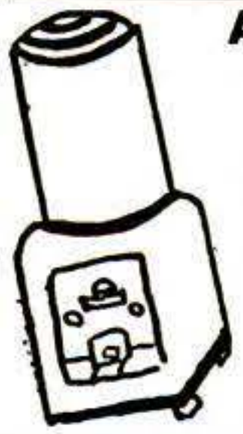

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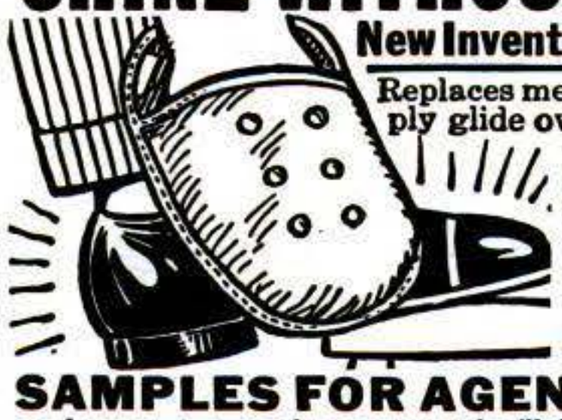

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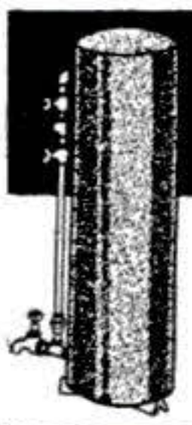

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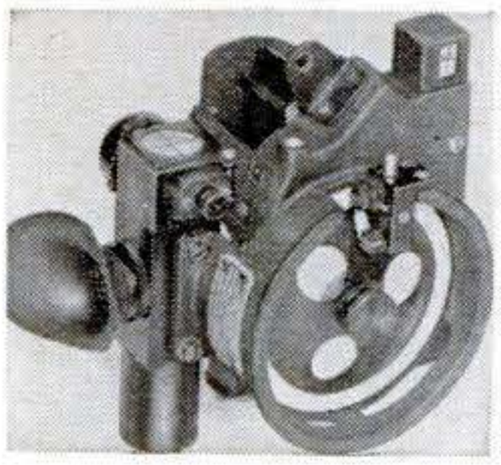

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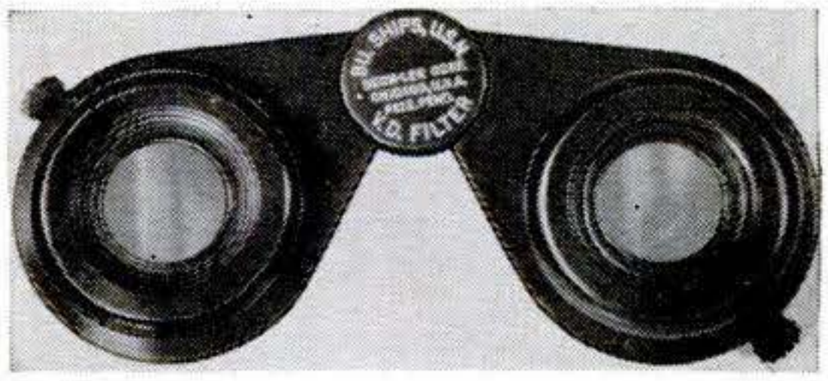

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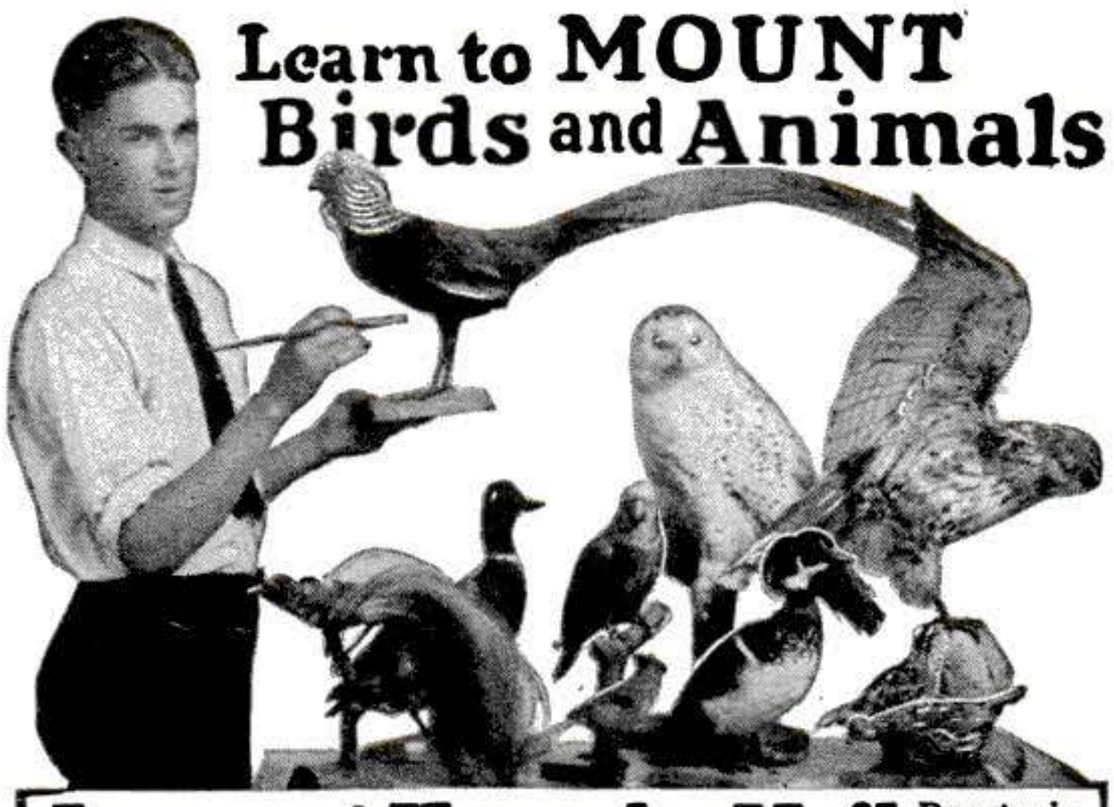

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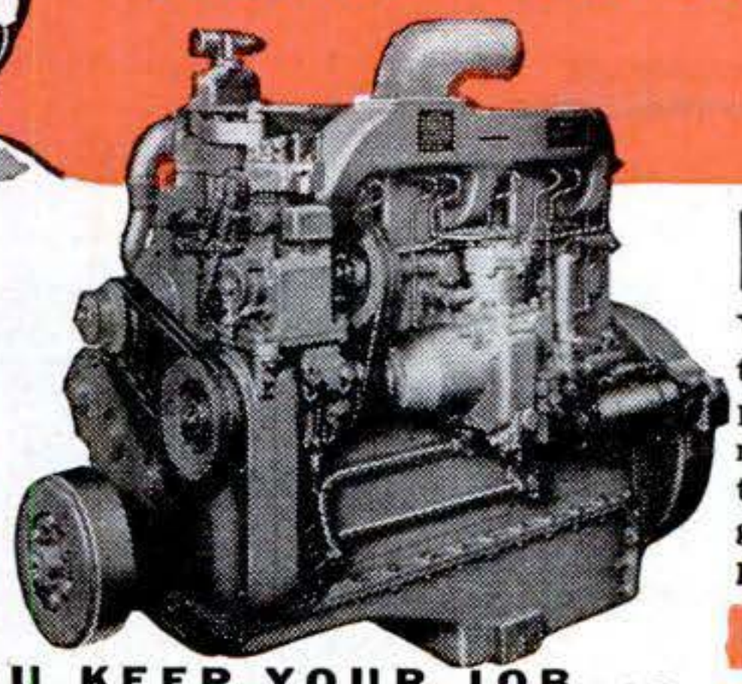

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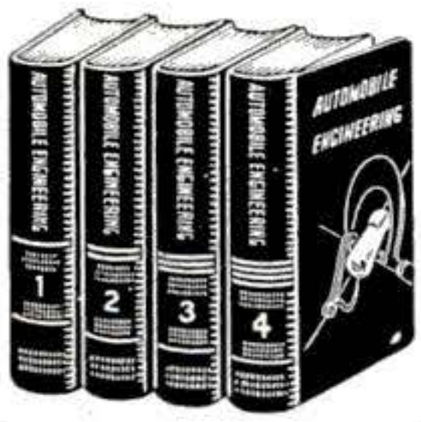

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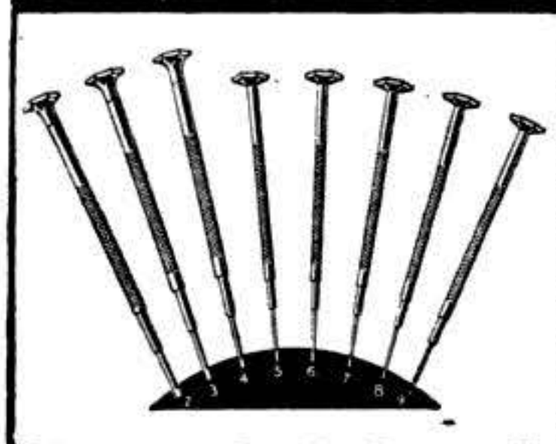

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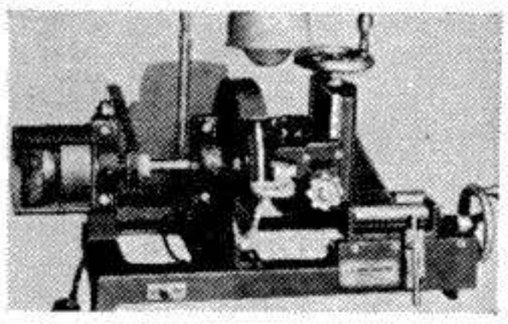

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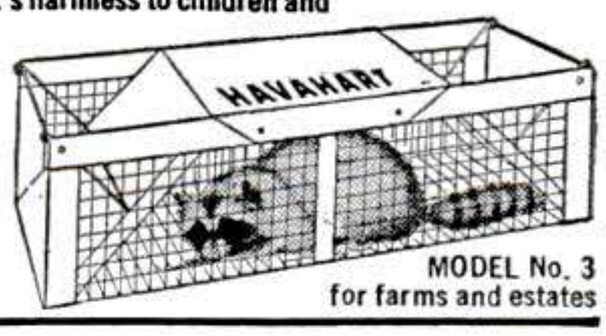

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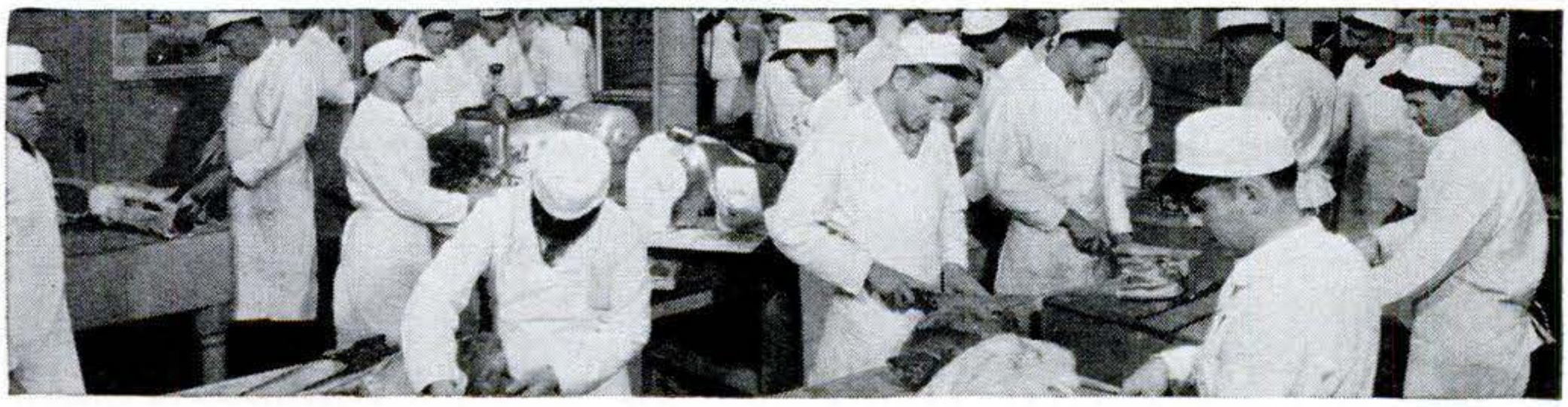

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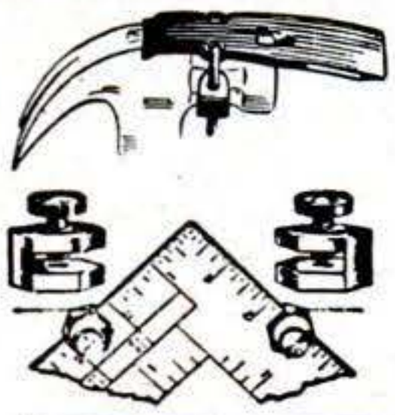

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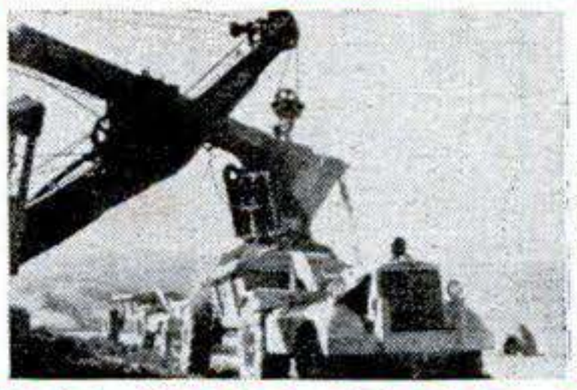
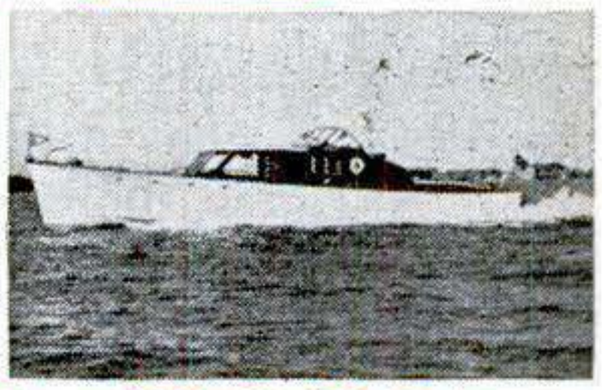

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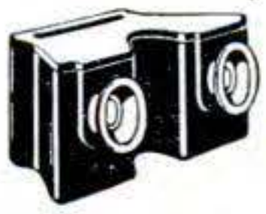

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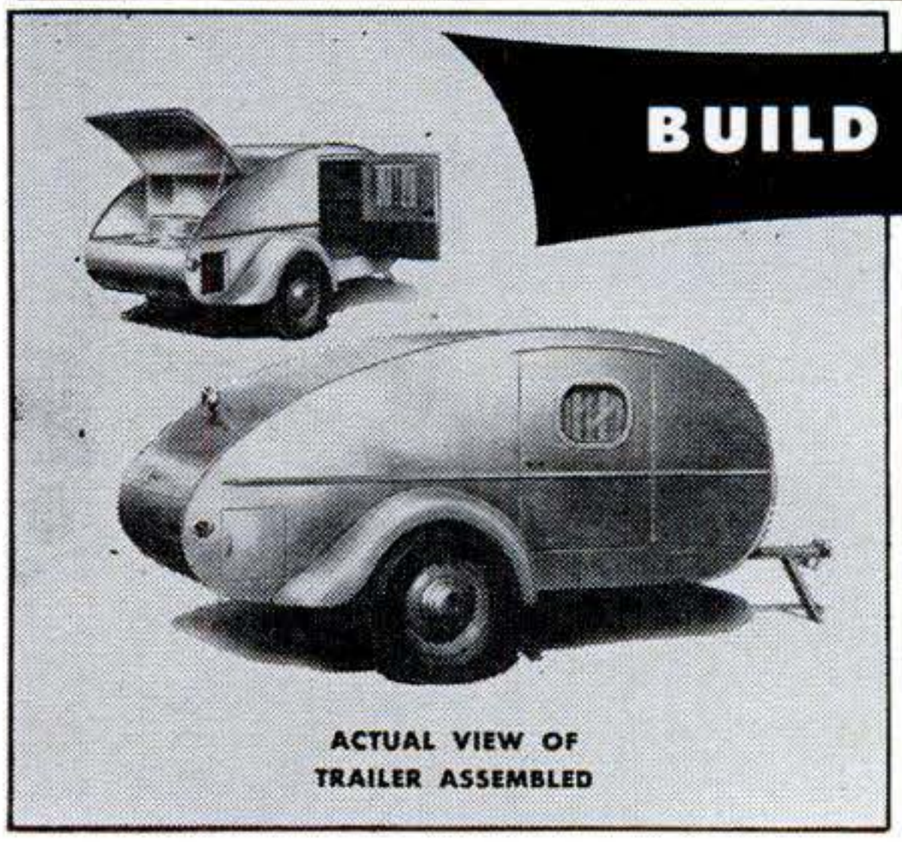

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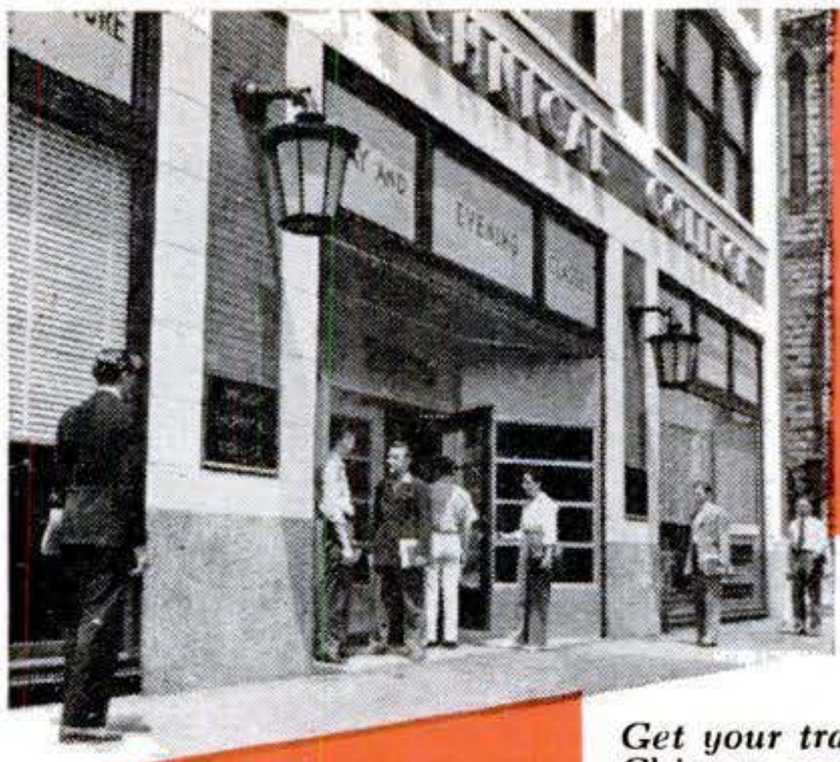

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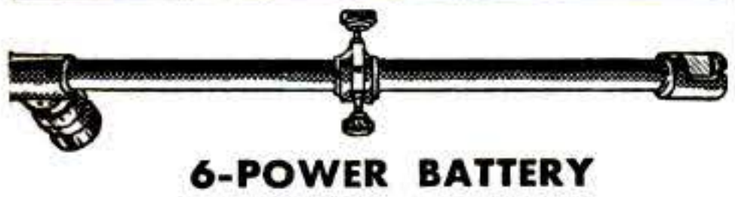

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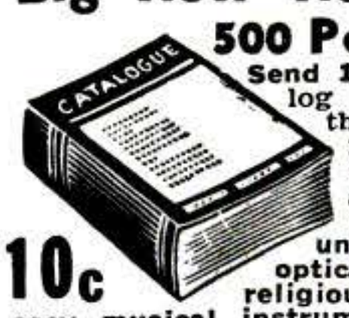

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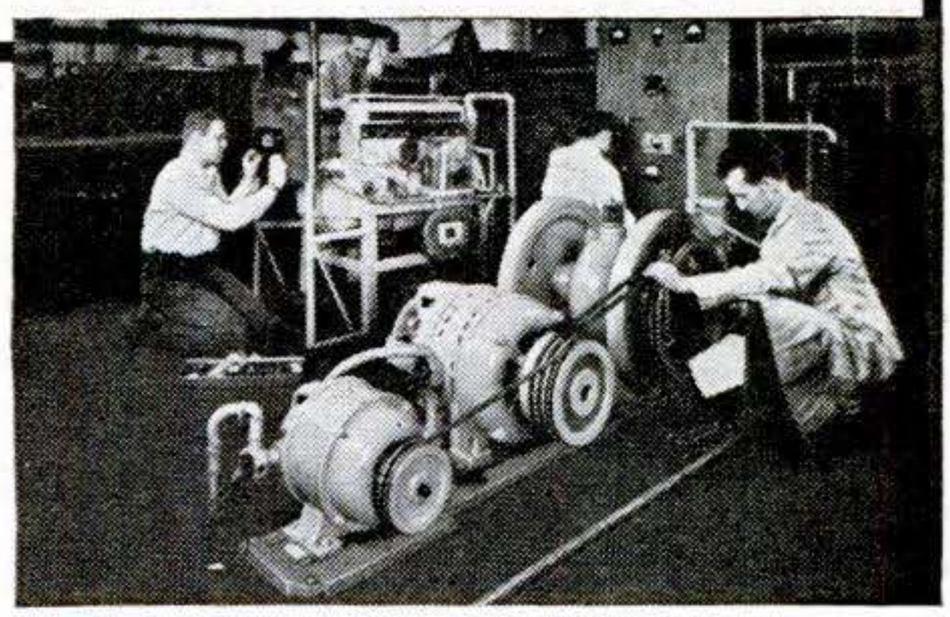

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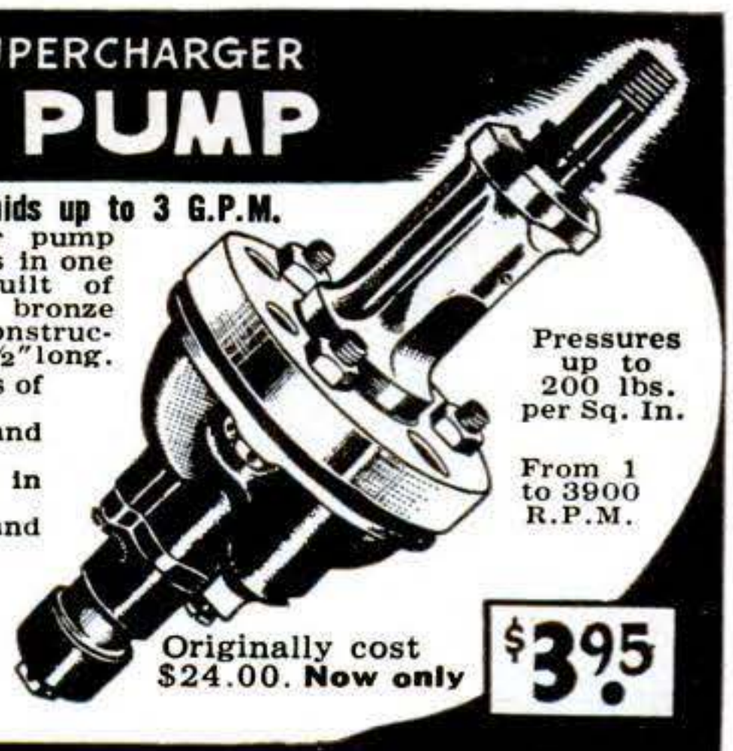

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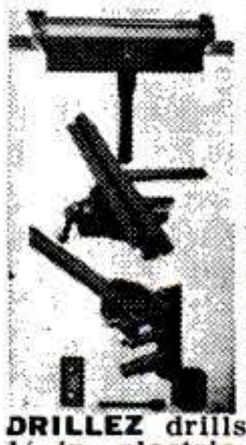

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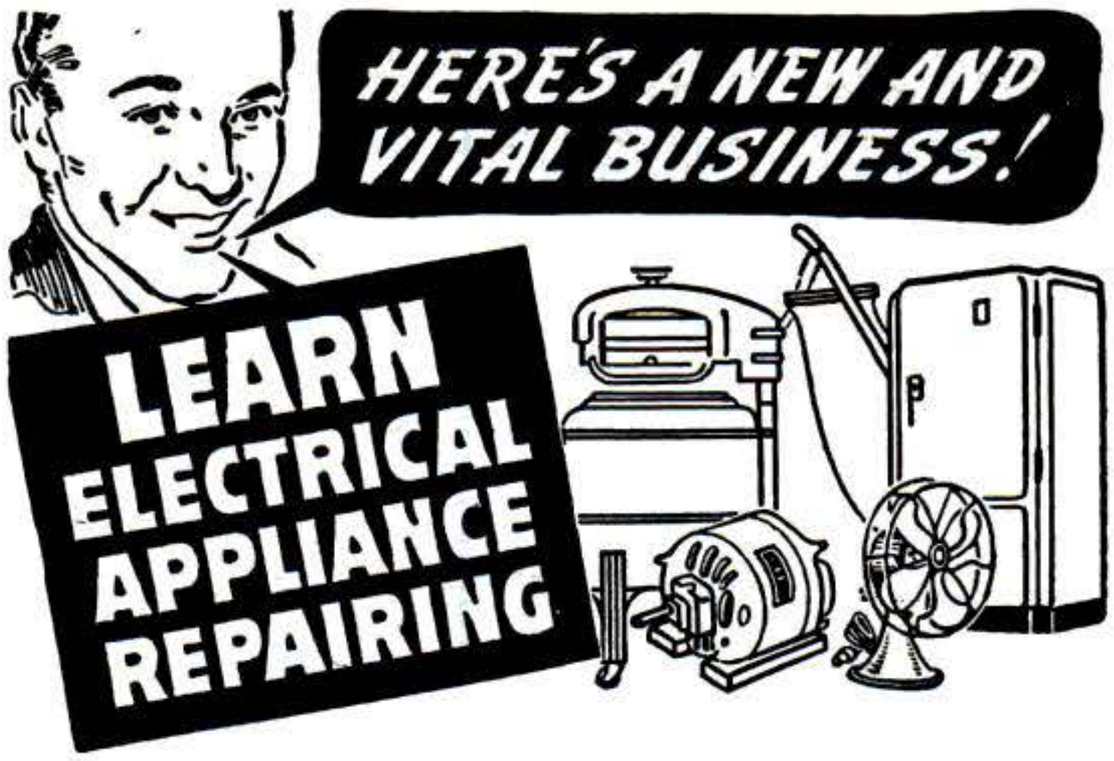

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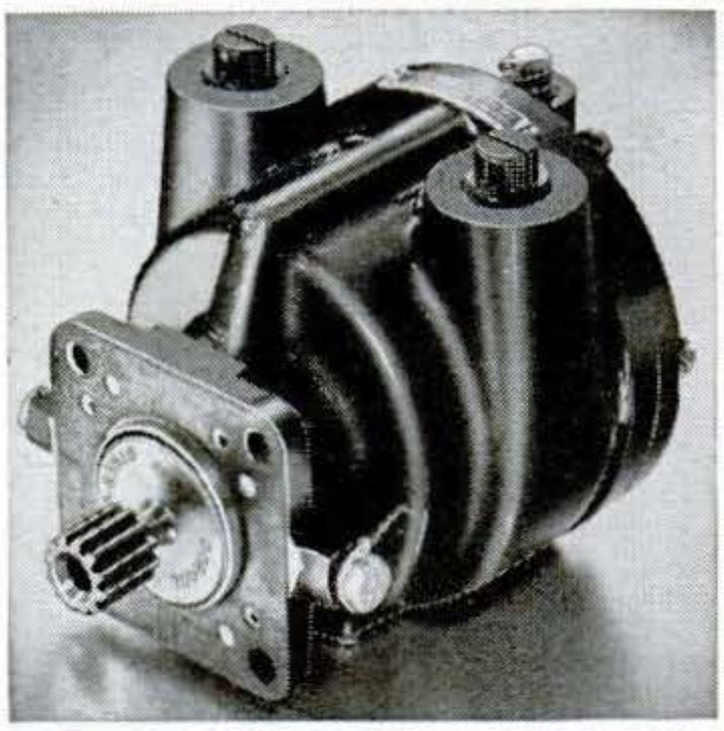

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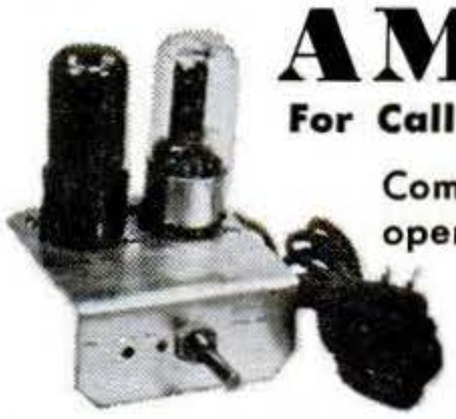

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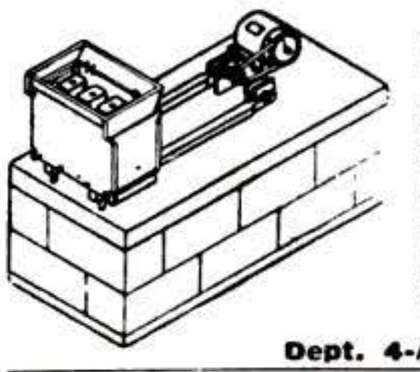

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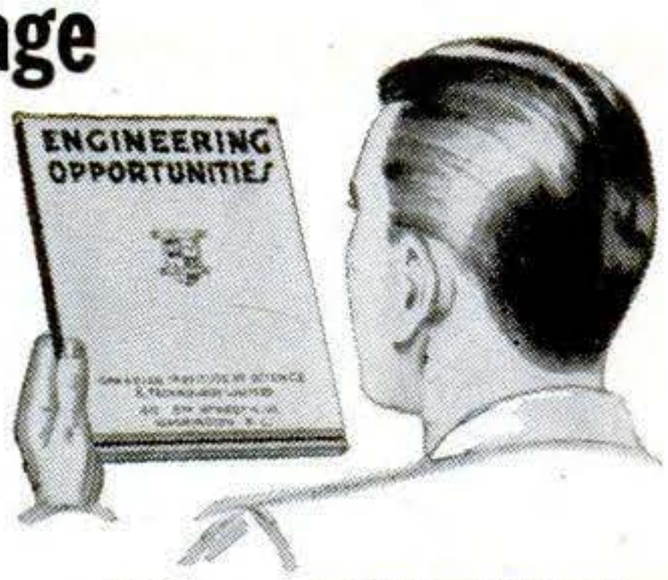

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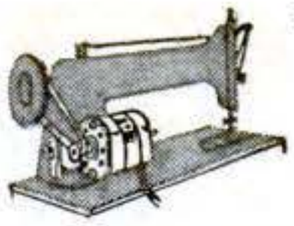

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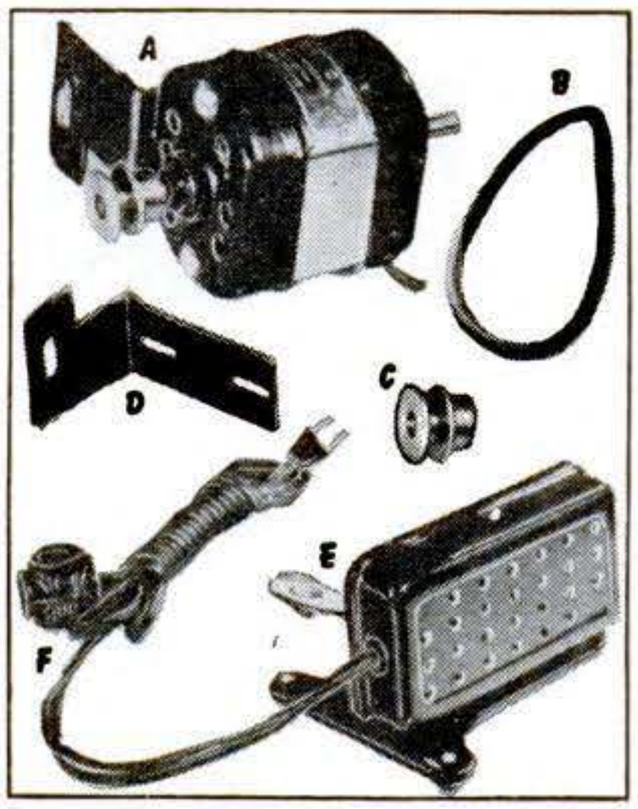

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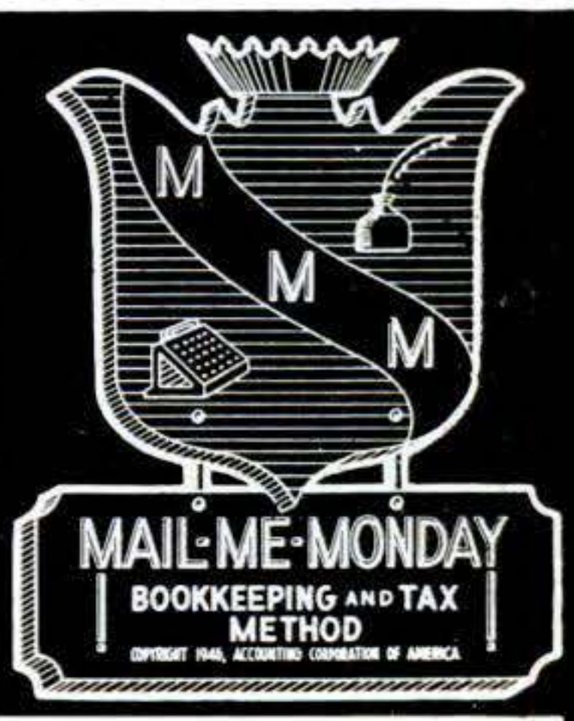

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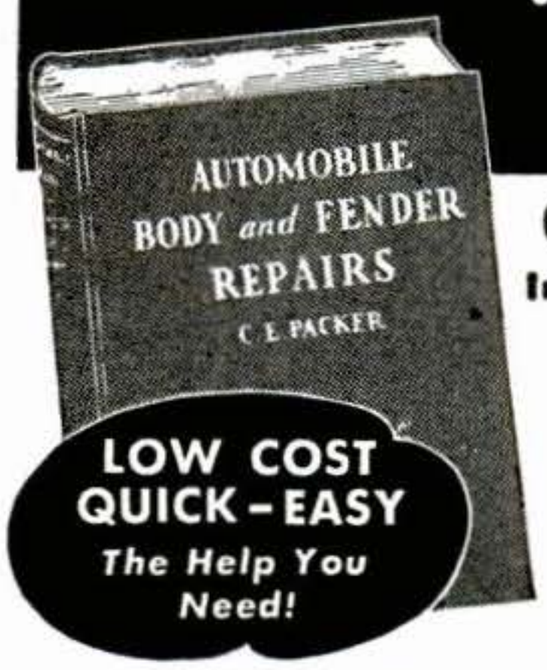

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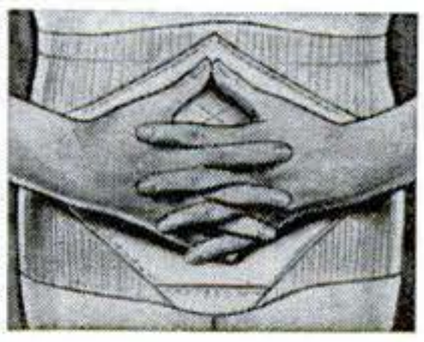

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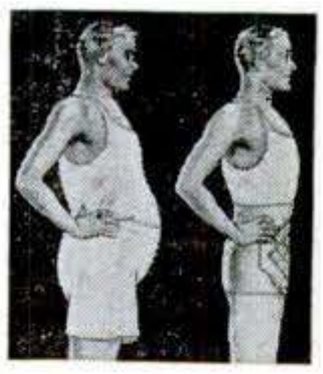

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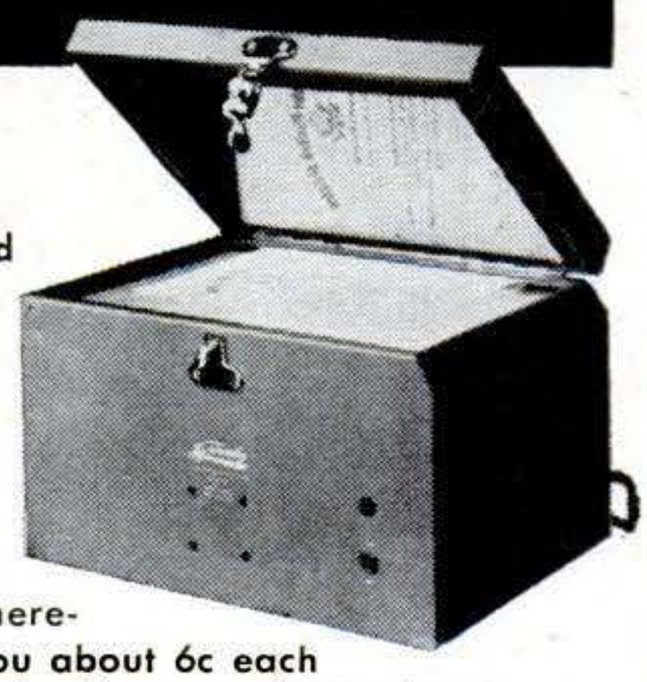

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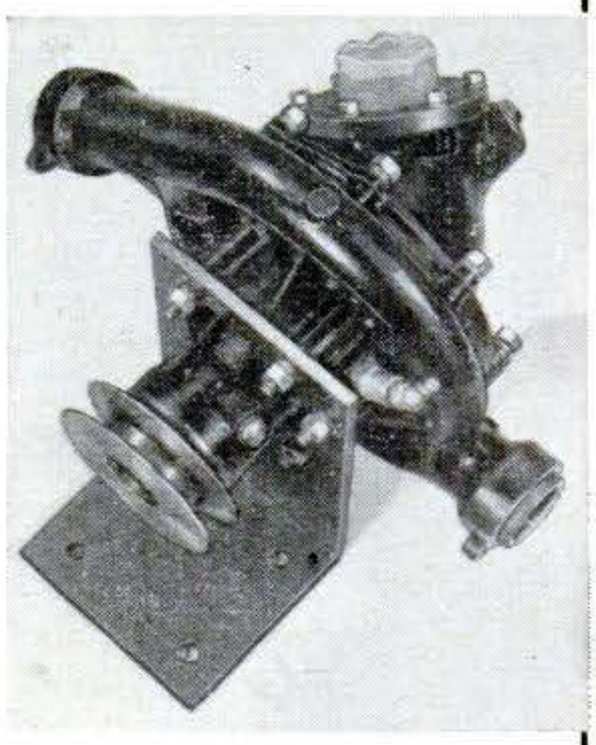

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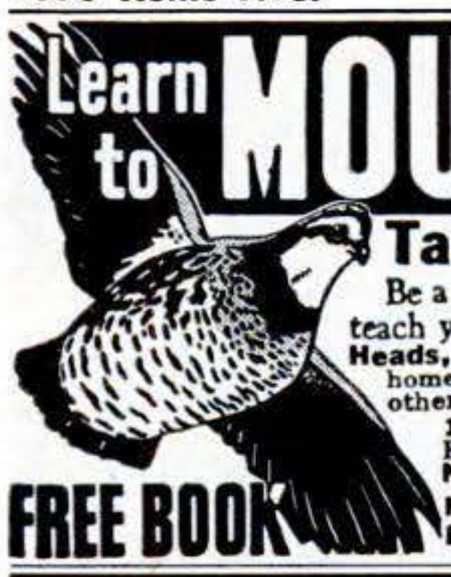

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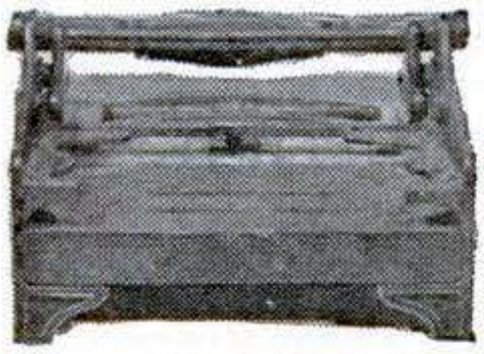

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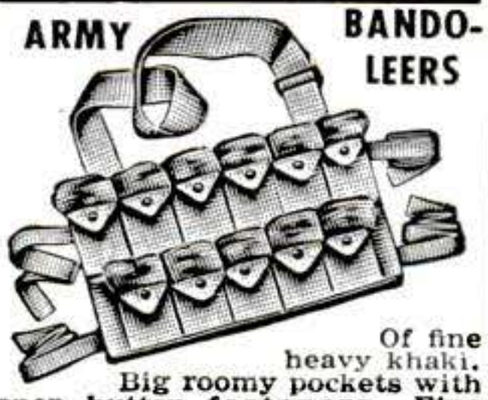

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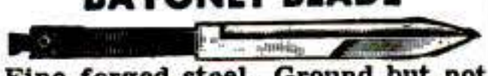

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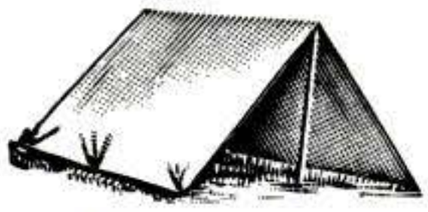

Regulation Army Pup Tents of durable, brown canvas. Used, but in good condition. Fine for campers, outdoorsmen, boy scouts, etc. Wgt. 8 lbs. **A100**—Tent only.... **$3.95**
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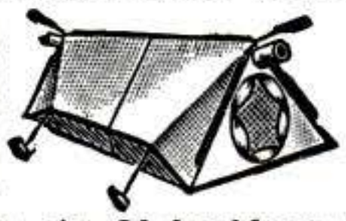

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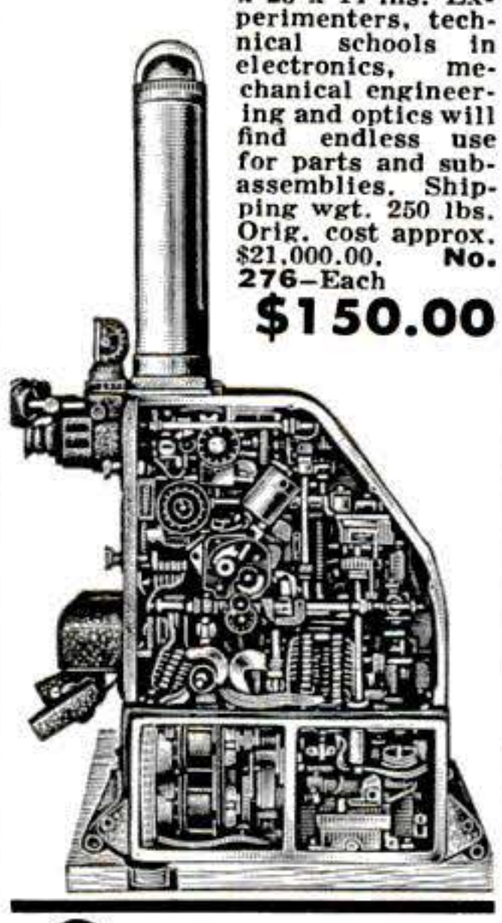

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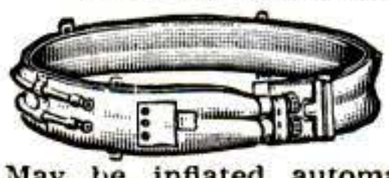

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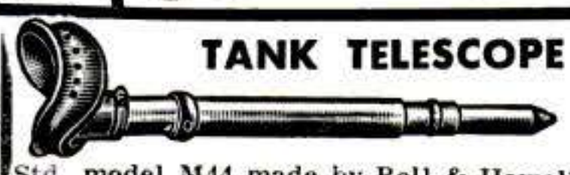

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"RECONDITIONING Engines & Cure Oil Pumping Without Overhaul!" Simplified Procedure includes "Tuneup" & Economy Tips for Better performance! Manual $2. E A Engineering, Box 660-G, Brooklyn 1.

13 AUTO SUPPLIES & EQUIPMENT

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NEW 1947 Crosley Engines—$190.00 Exchange Largest stock of Crosley parts in the U. S. Witkin-Borshell Co., Inc., 217 S. La Brea Ave., Los Angeles 36, Calif.

14 AUTO TRAILERS

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91 MOTORCYCLES, BICYCLES, SUPPLIES

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15 AVIATION

GIANT Glider Kites. Double. 14x10 ft. Lifts 100 lbs., tows car, etc. Cost Government $108. Yours for $20. Satisfaction guaranteed. Great Northern Mart, North Adams, Mass.

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49 ELECTRICAL SUPPLIES & EQUIPMENT

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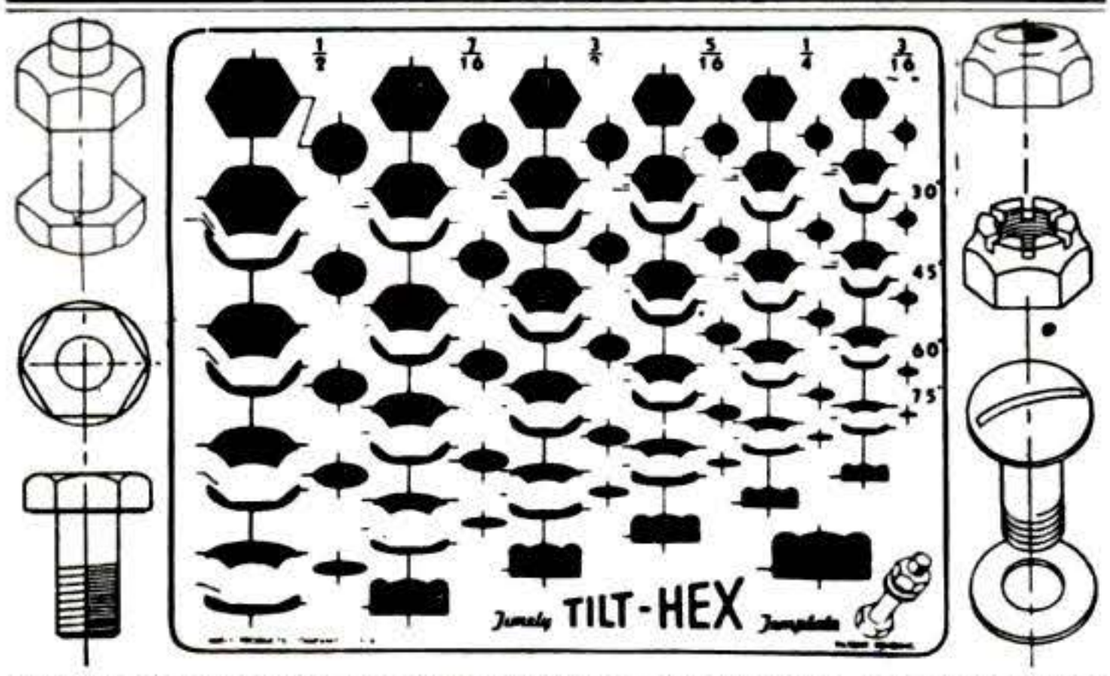

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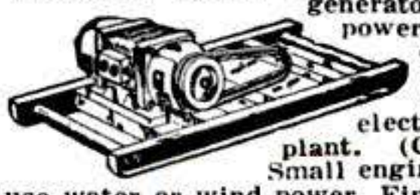

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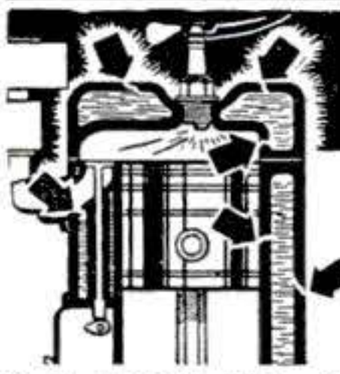

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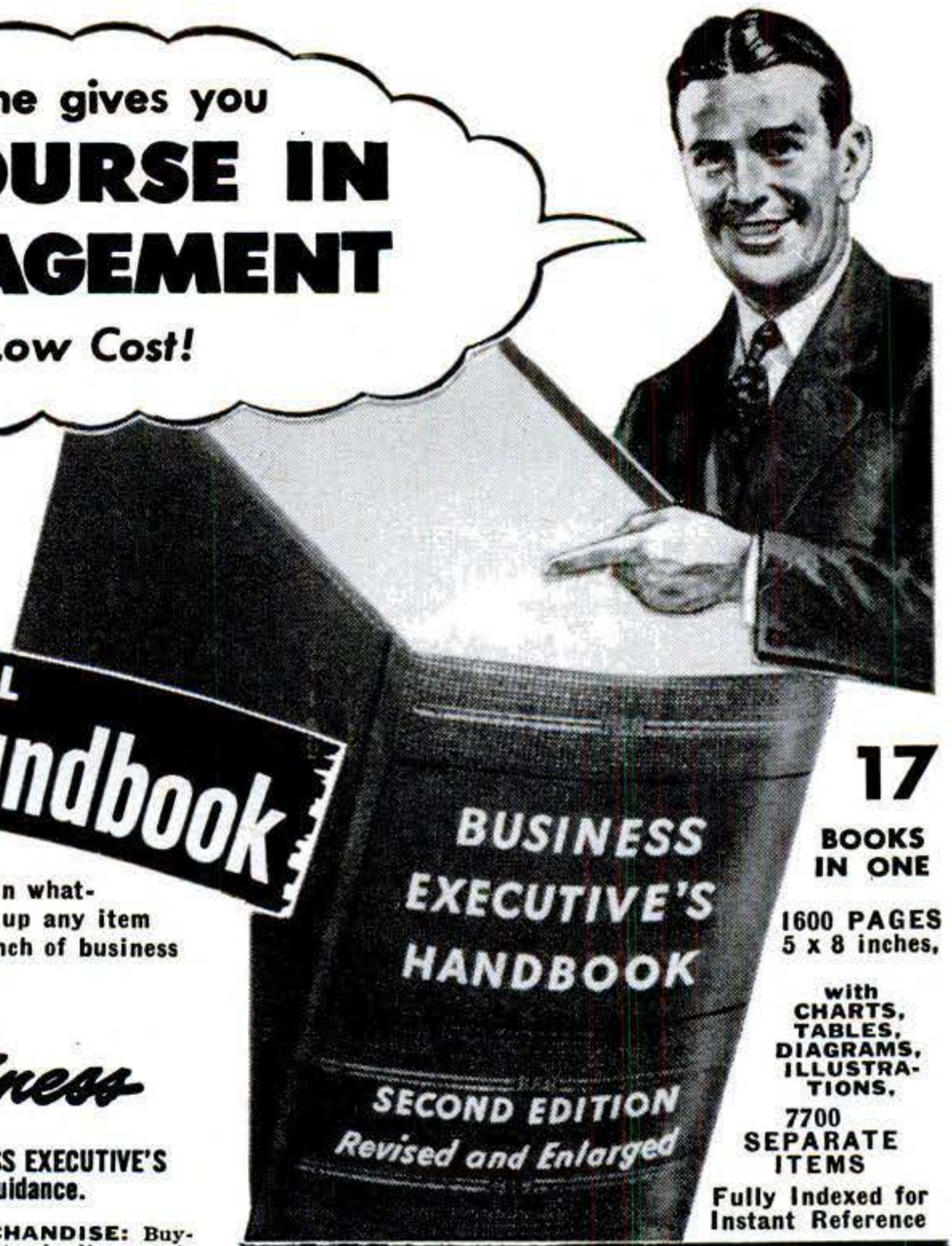

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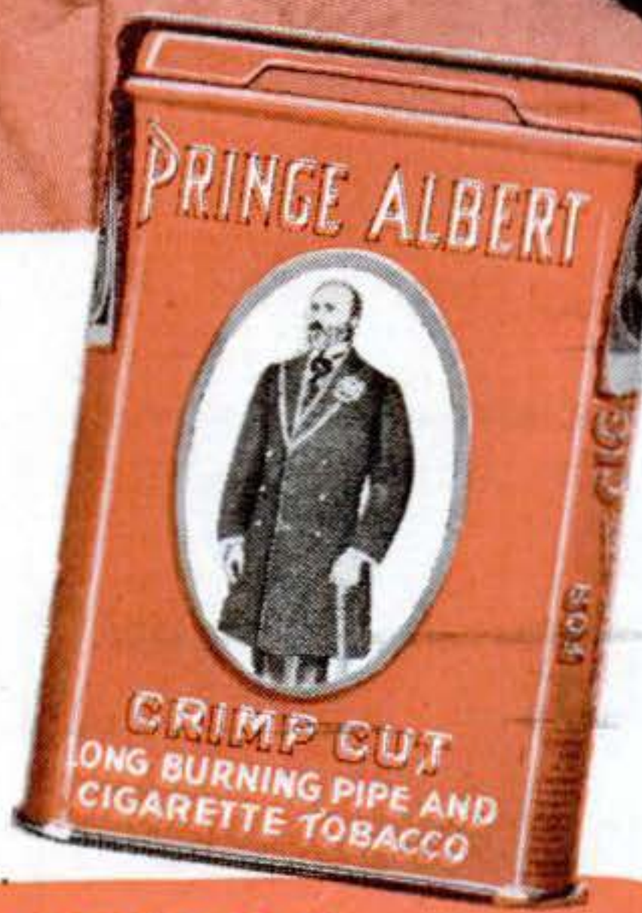

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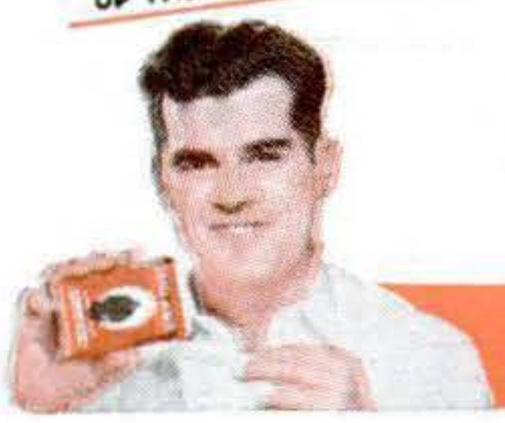

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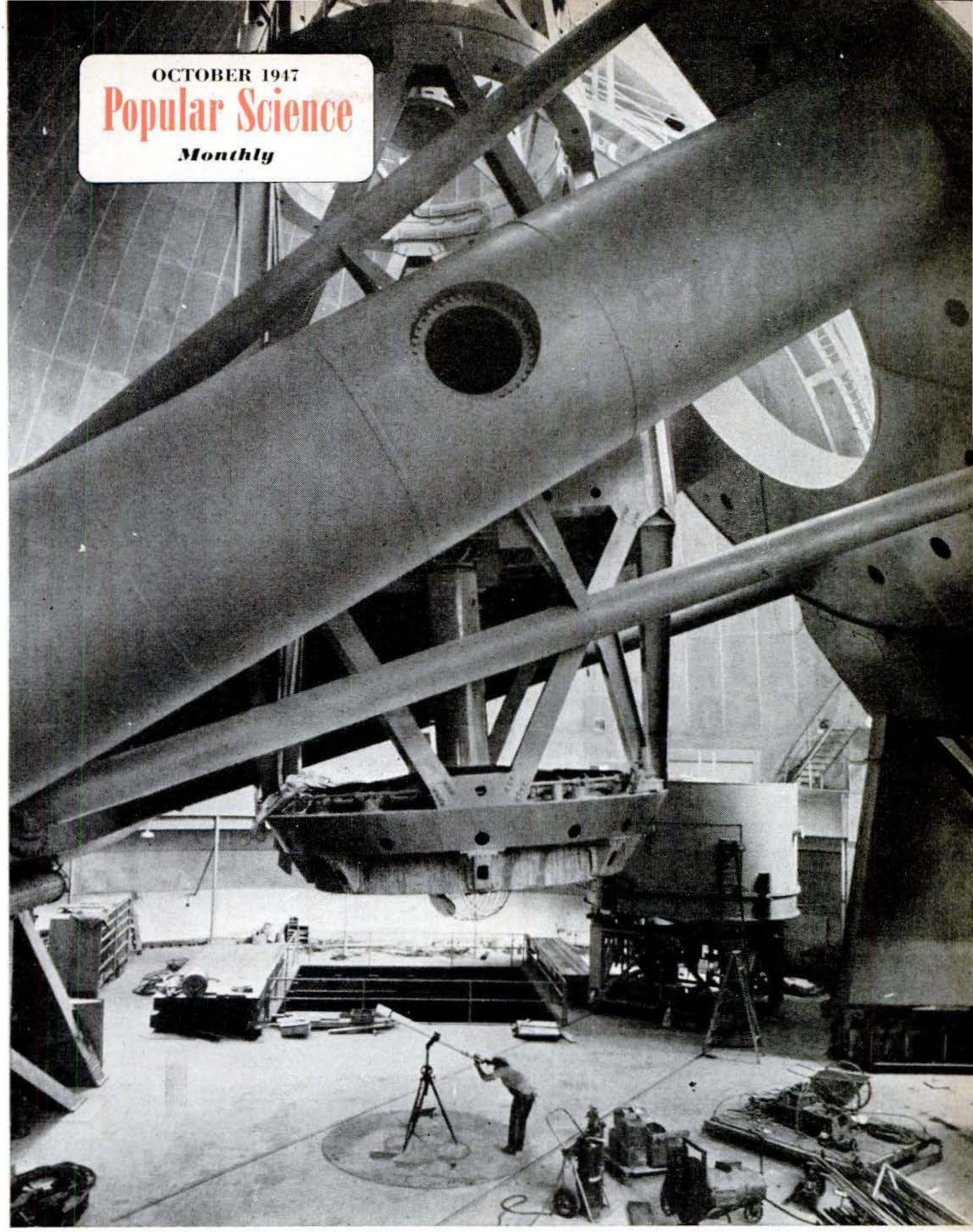

Study in 'Scopes . . . An idea of the huge size of the new 200-inch Palomar telescope can be gained from the contrast with the four-inch, back-garden model shown below it. The small 'scope and the man looking through it are dwarfed by the huge mass of the mirror holder above them. The holder contains a concrete disk of the same size and weight as the 15-ton mirror. This enables scientists assembling the 500-ton, five-story telescope to line it up without waiting for the mirror to arrive from Cal Tech.

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Transport designers are ready to go ahead with turbojets.

Taming the

By Devon Francis
PSM Photos by W. W. Morris

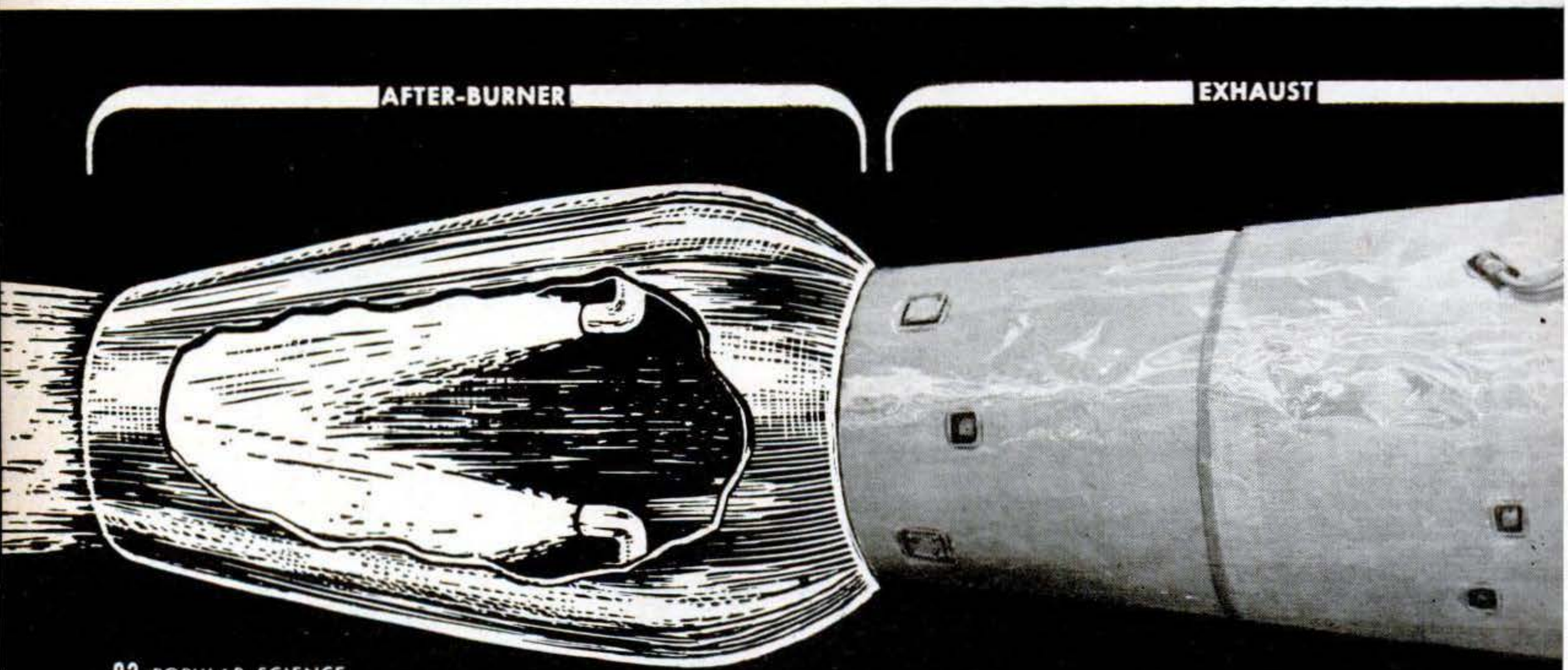
THE gas turbine, with its yawning tailpipe and flaring jet, is an aircraft designer's dream of packaged power. It is also his nightmare.

Barely on the edge of its potential development, it already has solved scores of problems piled up through years of wrestling with pistons and propellers. But for every problem it answers, it presents a dozen of its own. Most of its headaches, of course, arise from its very newness. Hardly any two engine experts agree today on how to tame the turbojet—but all of them are in there trying.

The latest and most spectacular effort to harness its fiery thrust illustrates the turbojet's contrariness: although the logical course would be to limit its power to tractable proportions, the engineers are hard at work *trying to double its already tremendous output.* By crossbreeding the turbojet with a ramjet, in a combination powerhouse called an after-burner, (see cover) they now believe that they can get twice as much power in short bursts at certain speeds.

That's only one of many contradictions. Until you get to know the true temperament of the turbojet, it seems to have everything. It is practically vibrationless and, if the tailpipe is put far enough aft, almost noiseless. The cockpit of a jet plane is a revelation in

The after-burner, a Westinghouse development, is actually an extension of a jet's tailpipe, as shown in drawing below. It consumes three times as much fuel as turbine-compressor unit.



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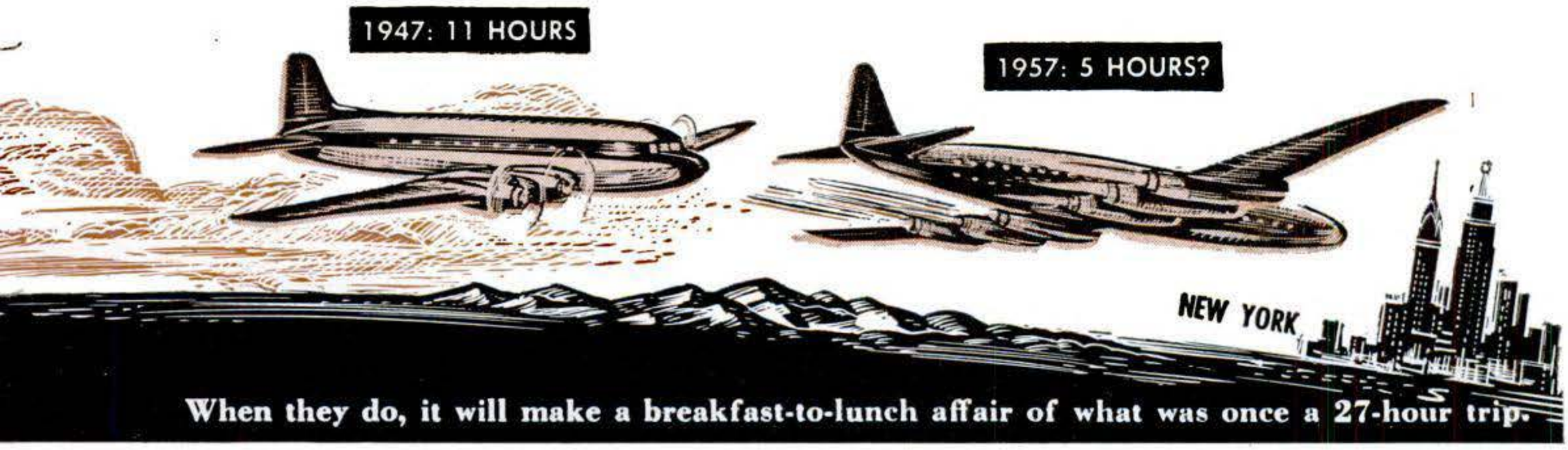


When they do, it will make a breakfast-to-lunch affair of what was once a 27-hour trip.

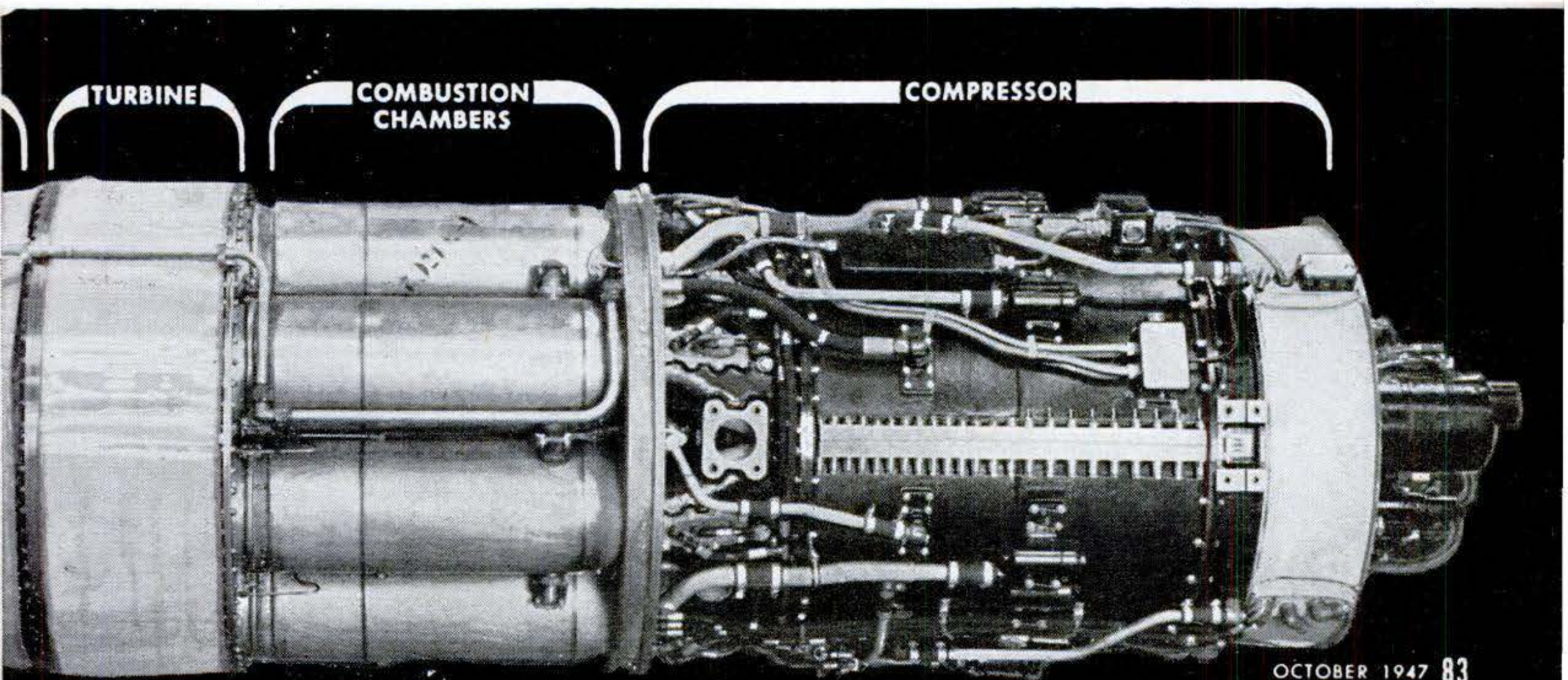
Turbojets

simplicity. The engine itself is compact. It can be encased in a fuselage or nacelle as slim as the hull of a racing yacht. It has no continuous ignition system, no carburetor, no radiator. The compressor can supply air uncontaminated by oil or fuel for supercharging the cabin. If fuels of low ignition point are used, the fire hazard is correspondingly reduced. The oil consumption is low. The engine weighs less than half as much as a reciprocating engine of equal power. Above all, it is powerful. The new Allison 400 has a rating of 7,500 horsepower at 600 m.p.h.—far more than a piston engine has ever achieved.

But the turbojet is a sullen servant. It will not do a lot of things; it does others grudgingly. It is greedy of fuel. It exceeds the miles-per-gallon efficiency of piston and propeller only at very high speeds. It is ever impatient of a rein. The compressor blades of the axial-flow type "stall out" at low speeds, even as an airplane wing stalls and loses its lift. That can be dangerous at a moment when a pilot needs power.

The turbojet is particularly irascible at this point in its development largely because of its light weight and constant peak temperatures, with its speed of rotation as a contributing item. A reciprocating engine will fly from 200,000 to 300,000 miles with scant attention, but a gas turbine will only go a third or a fourth as far without an overhaul. The sheet-steel liners of combustion

Axial-flow TG-180, pictured with the afterburner, is no mean fuel-eater itself. Four of them, snuggled in the twin nacelles of an XB-46, can devour 10 tons of fuel per hour at 500 m.p.h.



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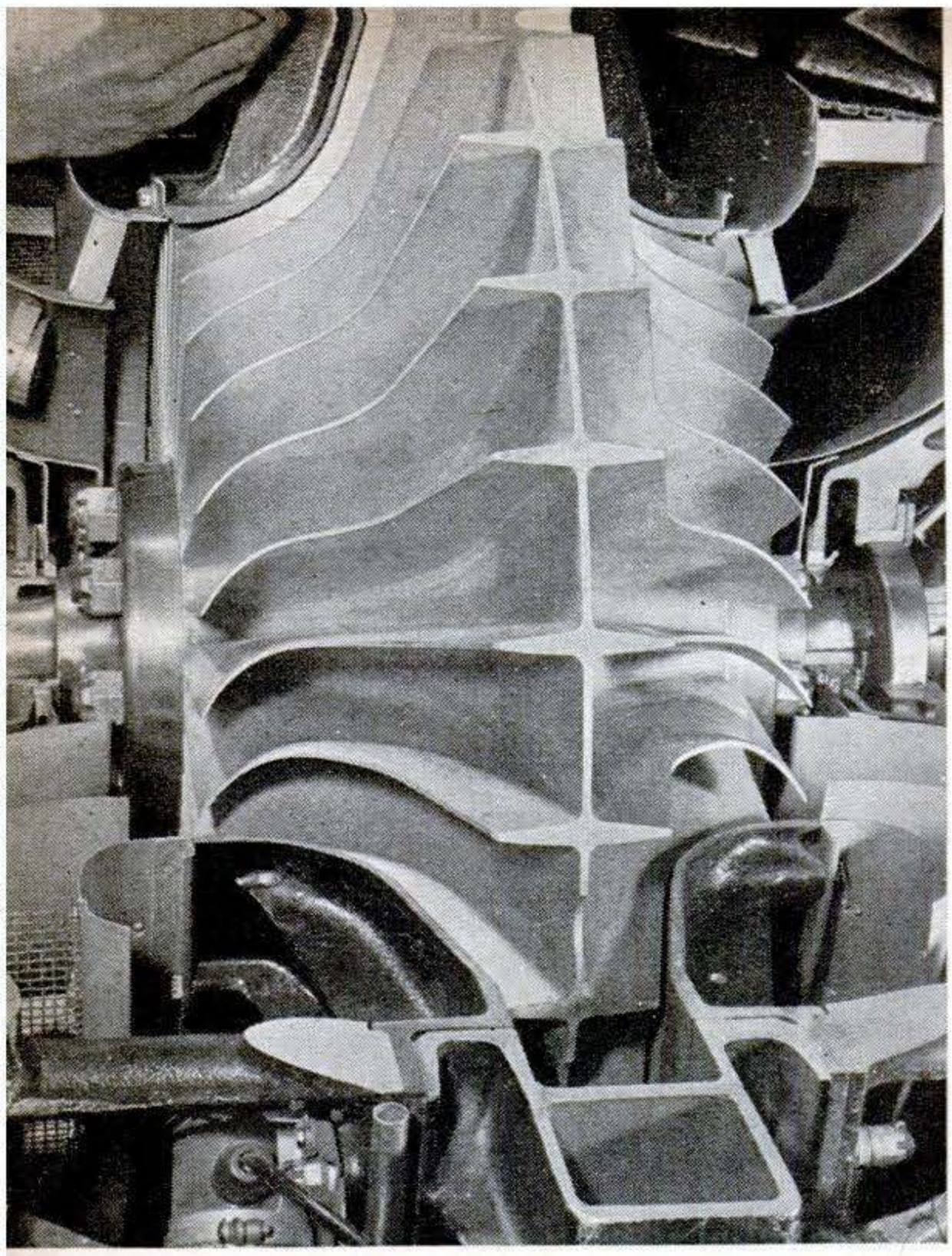
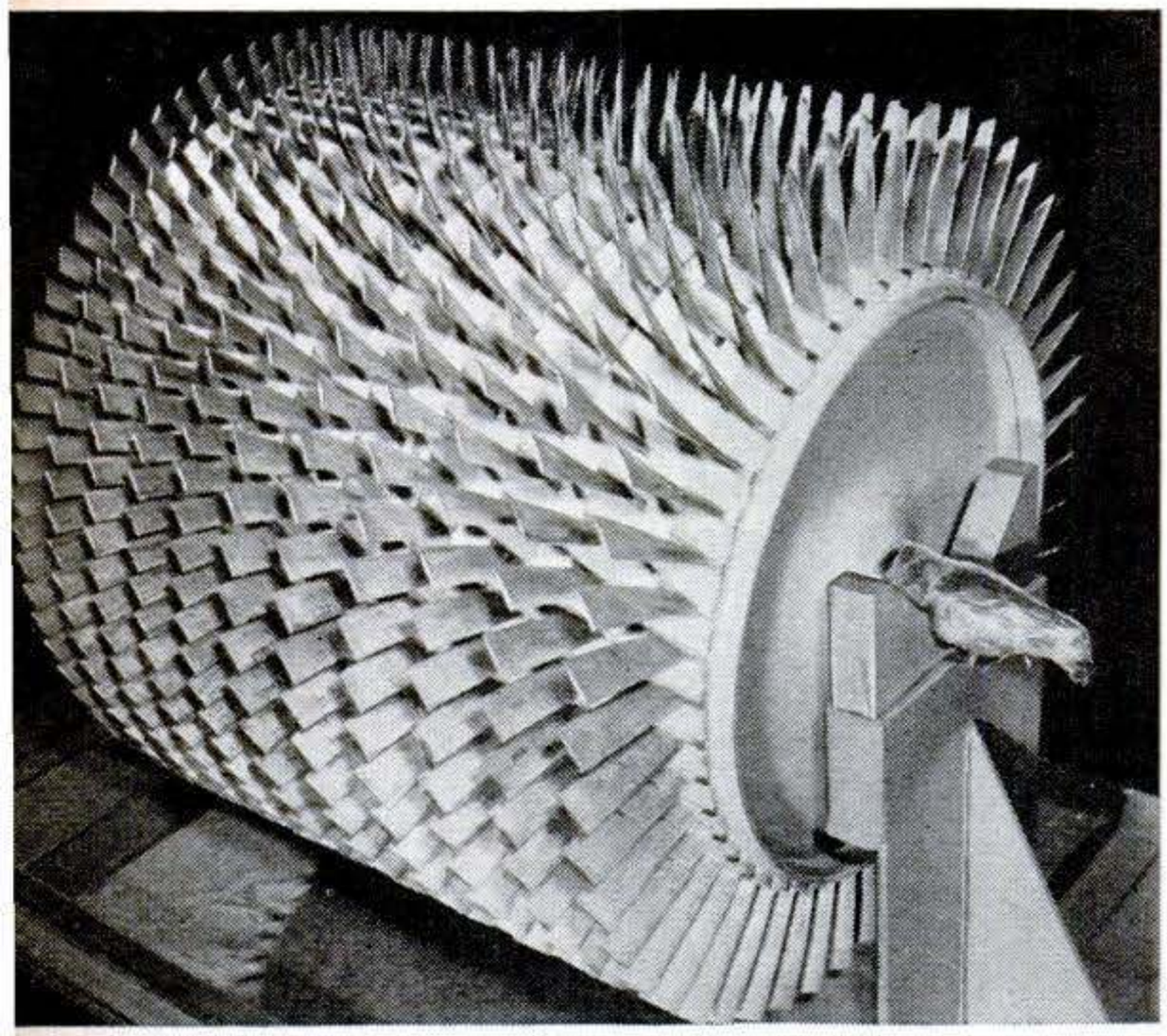


Compressor design is basic difference between centrifugal and axial-flow turbines. The I-40's compressor, above, has two units back-to-back to handle more air. Pencil indicates narrow clearance between wheel and housing, necessary to maintain pressure. Centrifugals are rugged and short-shafted, but have large diameter.



Axial-flow compressor is smaller in diameter, but is relatively more fragile and complex. These blades are in 11 stages (10 of aluminum alloy, one of steel to withstand compression heat) that build up a compression ratio of four to one. Axials turn at 7,000 to 8,000 r.p.m., as against 12,000 to 13,000 r.p.m. of centrifugals.

chambers and the buckets on the turbine wheel corrode, distort, or burn through. Tailpipes have to be replaced.

In the light of experience with piston engines, the remedy would appear to be simple. Don't cylinder temperatures run up to 2,000° as against a turbine's mere 1,400°? Sure—but there's a catch. The temperature in a cylinder head is high for a scant fraction of a second; that in a turbine remains high for hours on end.

Weight vs. Efficiency

They don't build them heavier to withstand the heat because as weight goes up, efficiency goes down. Worse, if they are going to beef up the turbine wheel, they must prepare for vastly increased centrifugal forces. Already these forces are at 20,000 multiples of gravity—enough to rip a turbine apart if anything goes wrong. One exploded the other day, in the test cell of a manufacturer. One moment it was whirling at almost 8,000 r.p.m., the roar of its exhaust muted by a muffler. The next moment it was in pieces no bigger than the palm of your hand. Nobody got hurt; concrete-and-steel walls stopped the fragments. But the accident shows what designers are up against.

The tailpipe, though spared any rotational stress, is a neat problem in itself. A thick-walled pipe would shatter like a goblet under a dose of boiling water if it were subjected to an outside air temperature of −50° and an inside temperature of 1,200°. It simply has to be made thin.

40 Metals Tested

Better metallurgy will answer part of this problem. Experiments were run with some 40 metals by the General Electric Company, pioneer of all turbine development in this country, before Iconel was adopted for combustion chamber lining. Most of the alloys used at critical points are combinations of nickel, cobalt, columbium and tungsten. No iron is used.

Ceramics will take a lot more heat than metals, but there again the surly nature of the turbine is in evidence. Ceramics don't have the strength to take the centrifugal forces involved. Perhaps ceramics can be rimmed with metal. The Germans tried it, and we are trying it now.

Such experiments, while a natural part of any engine's development, point up the lack of experience with jet propulsion. The

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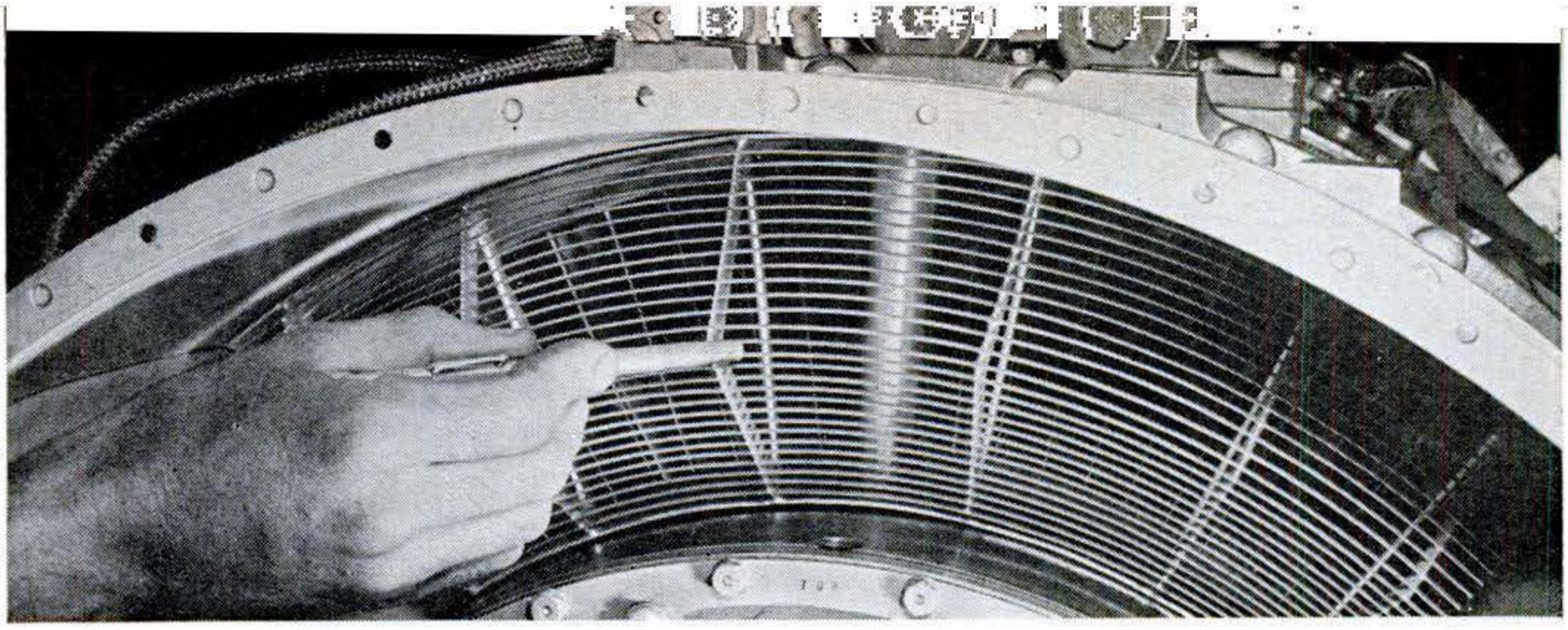
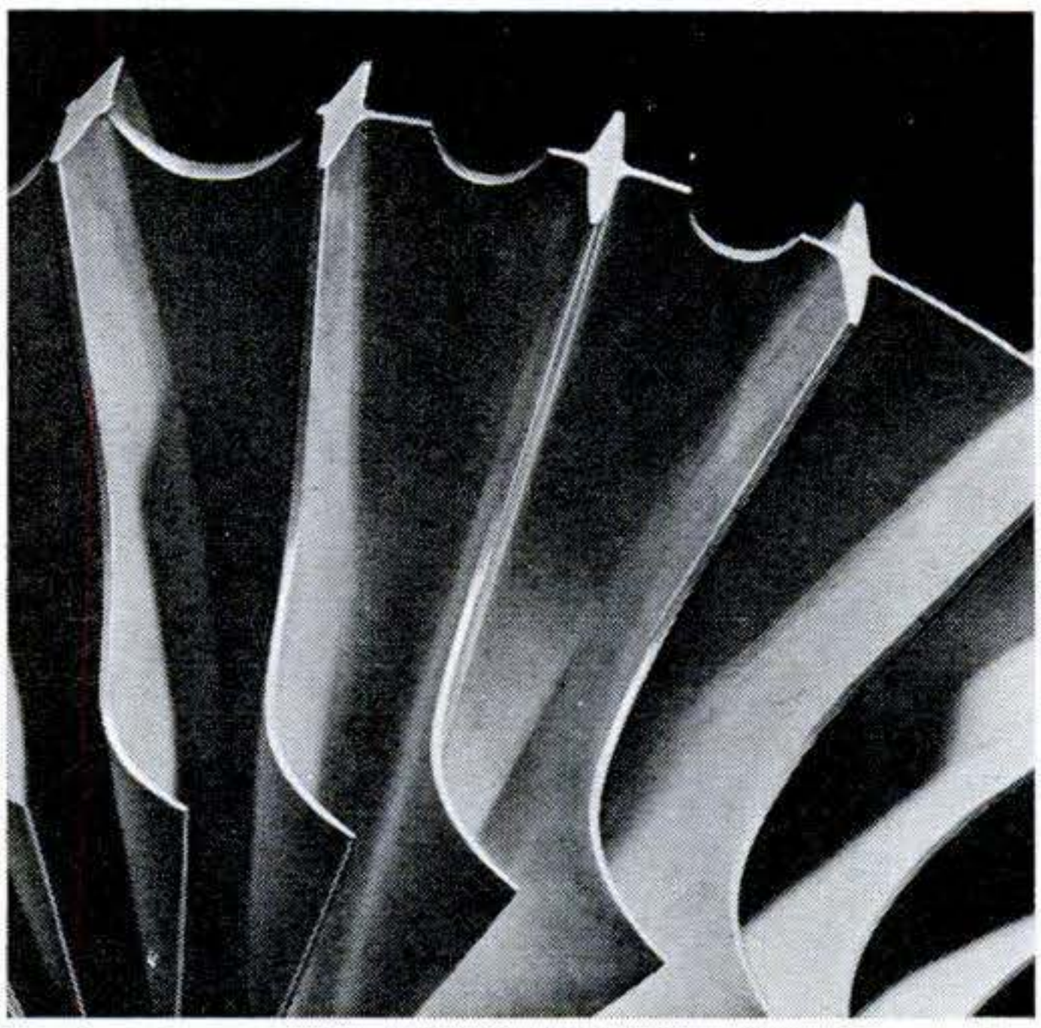
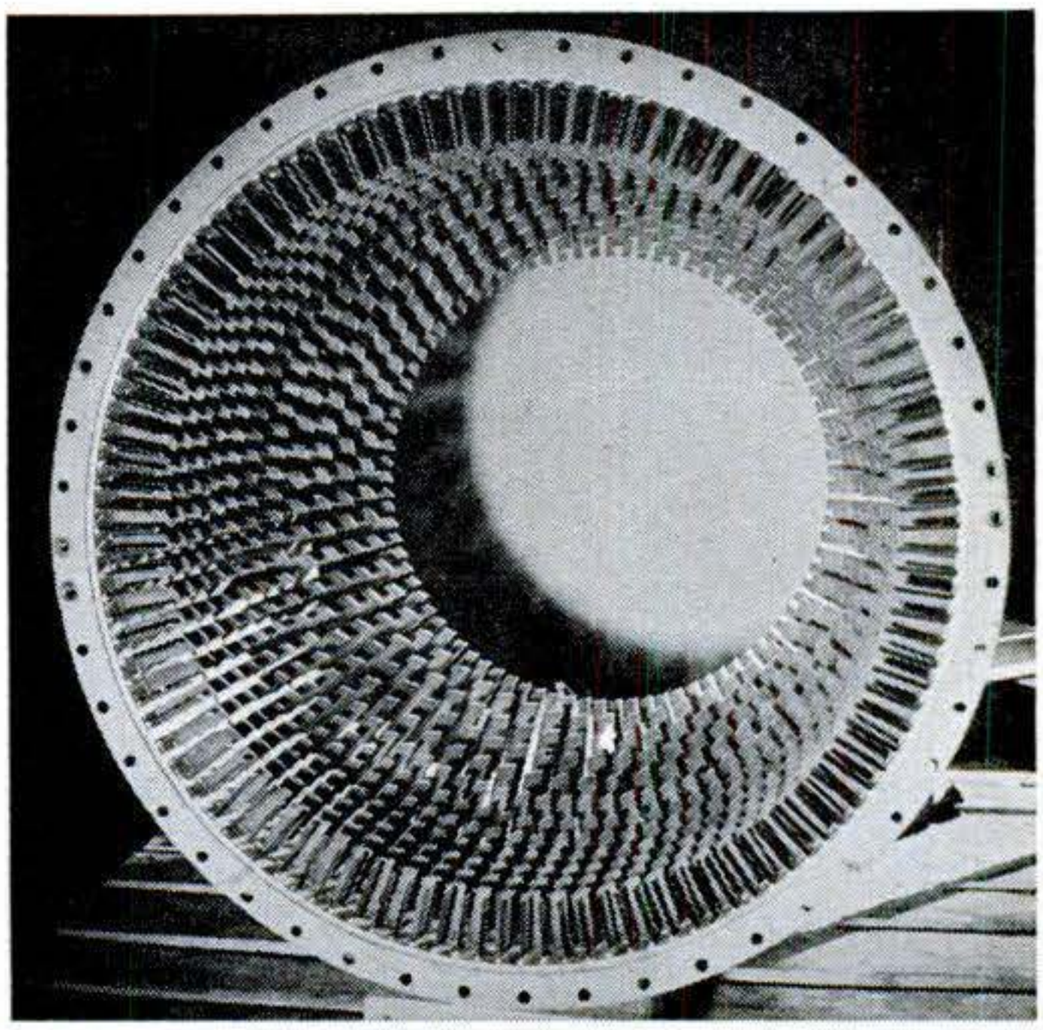


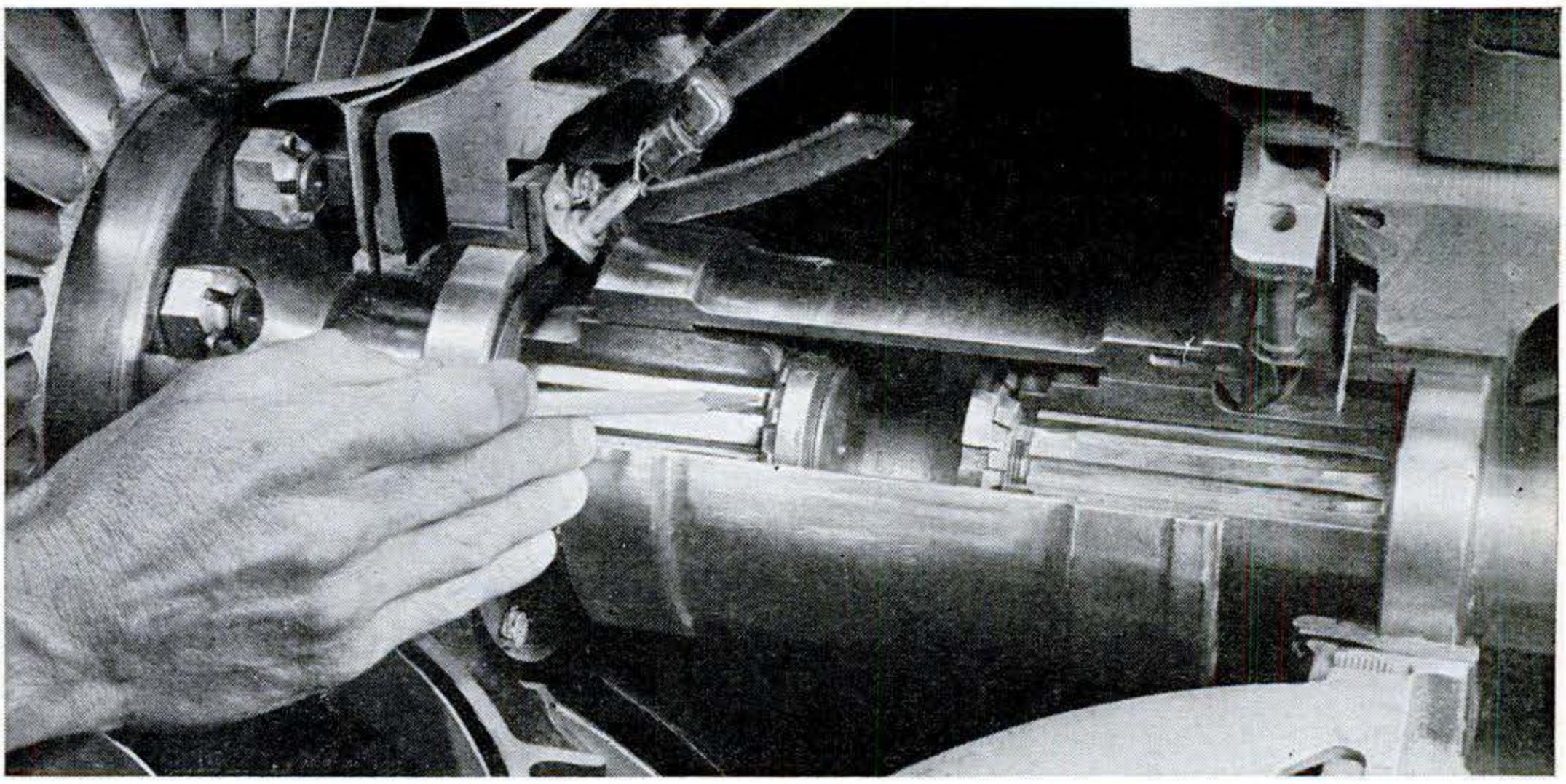
Heavy screen in front of compressor protects turbine's innards against damage from foreign objects in the air. Even without such damage, all aircraft turbines need frequent overhauls.



Cutout arcs between compressor wheel's blades achieve a balance so delicate that vibration of turbine at top speed scarcely disturbs the surface of a glass of water resting on engine.



Thicket of stator blades surrounds compressor wheel in axial type, correcting air turbulence by re-establishing even flow between each of the wheel's several stages of compression.



Temperature differences (from –50° to 1,400°) require divided shaft for expansion and contraction. Sleeve joining shaft ends in this centrifugal is between turbine and compressor.

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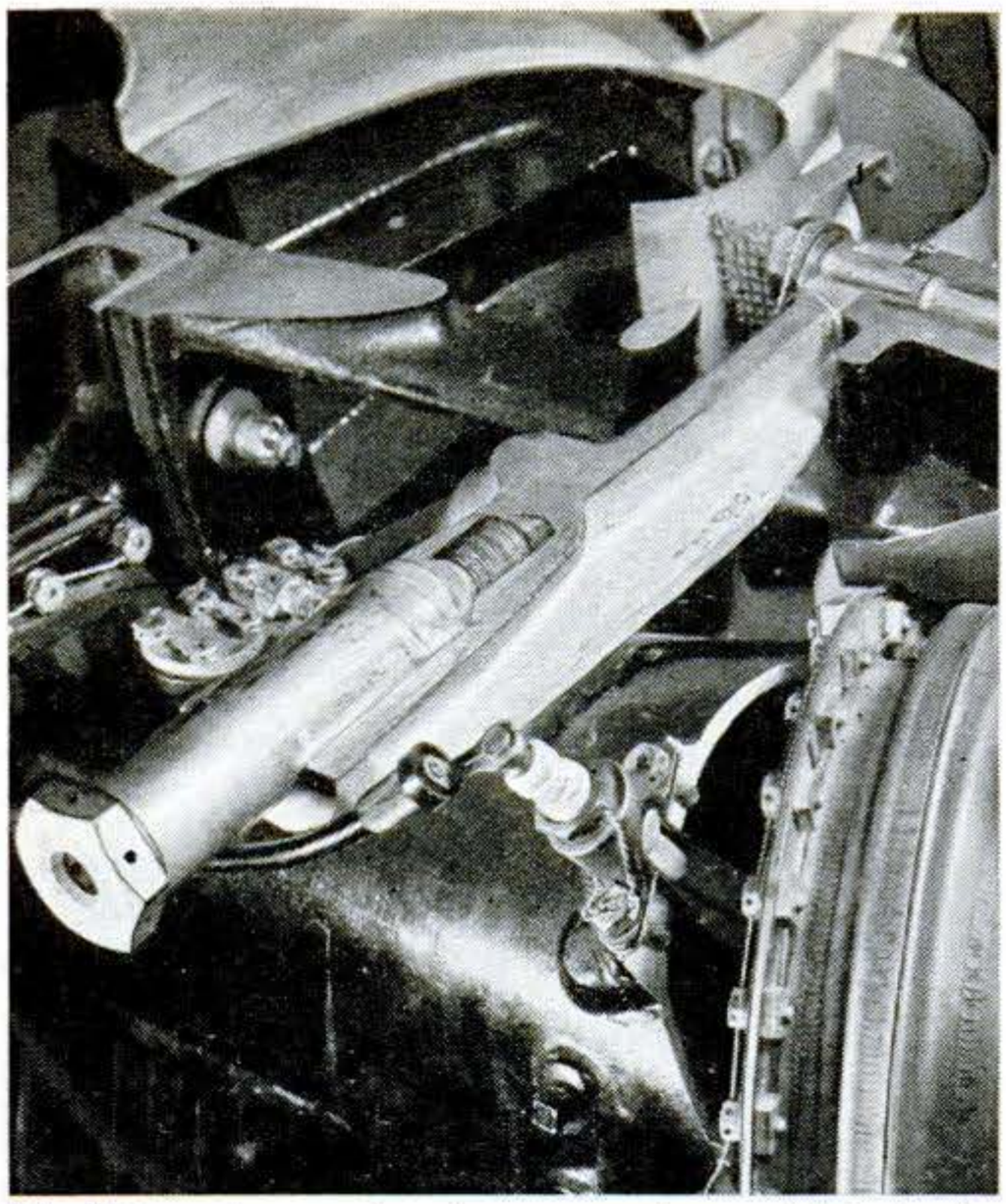
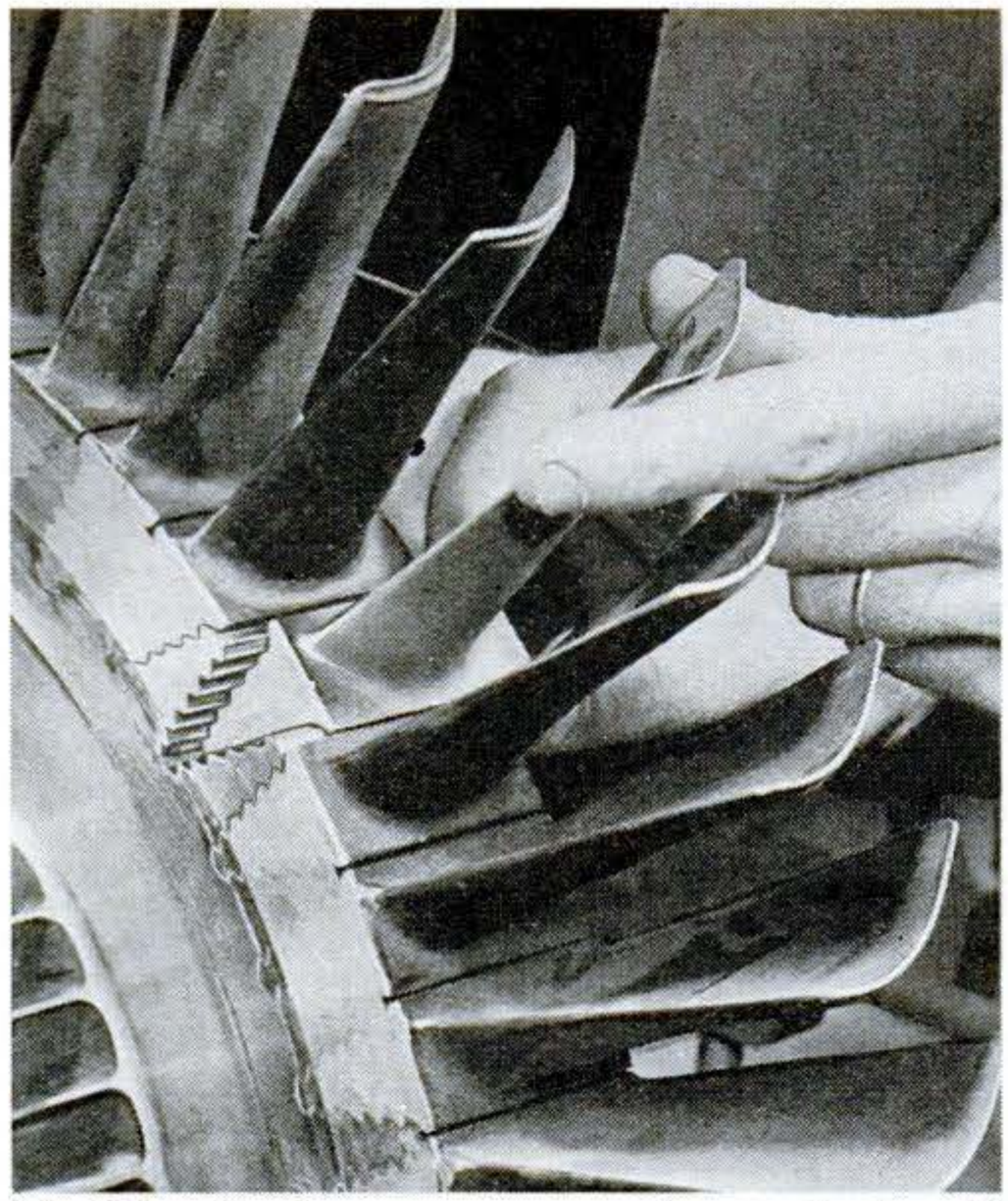
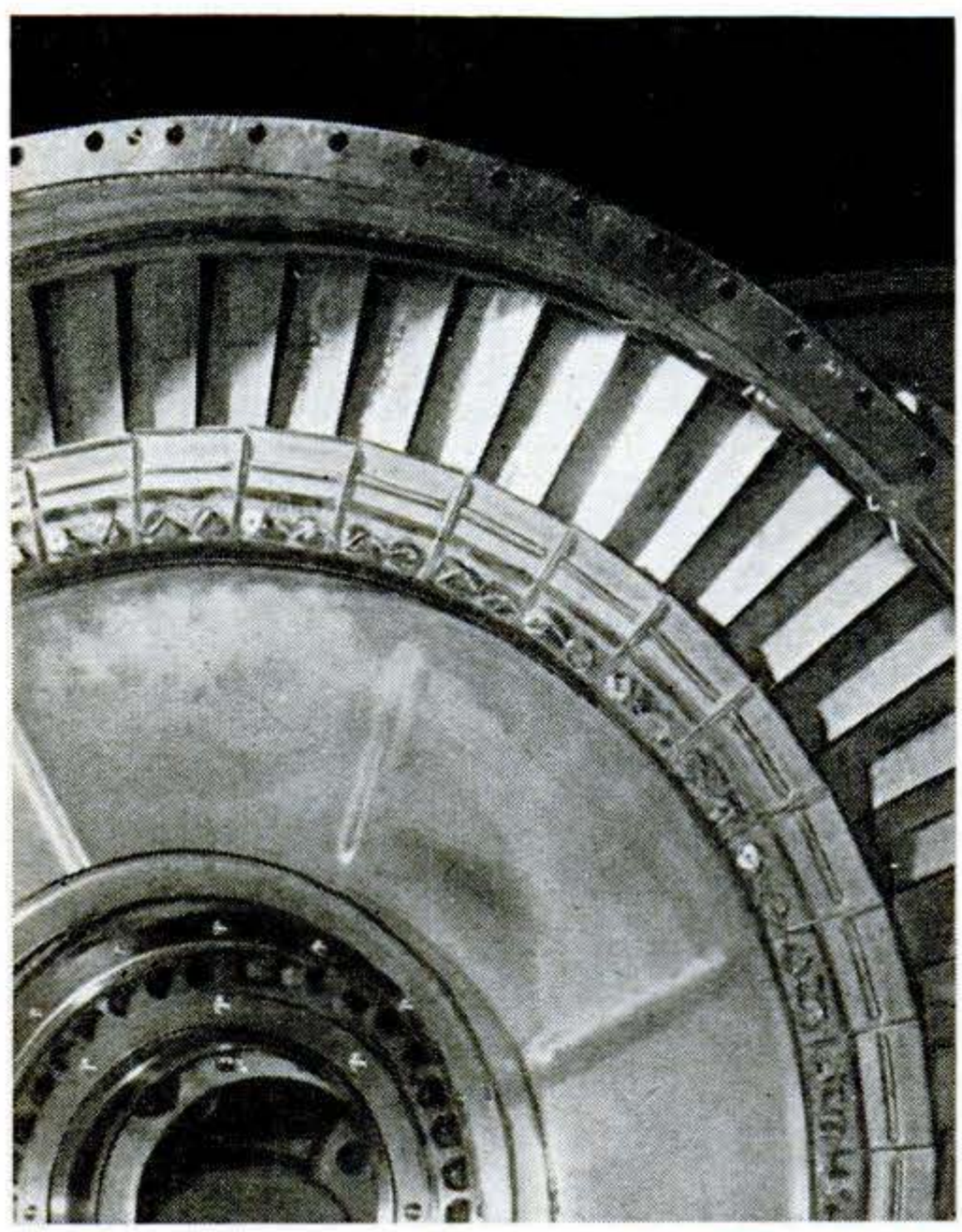


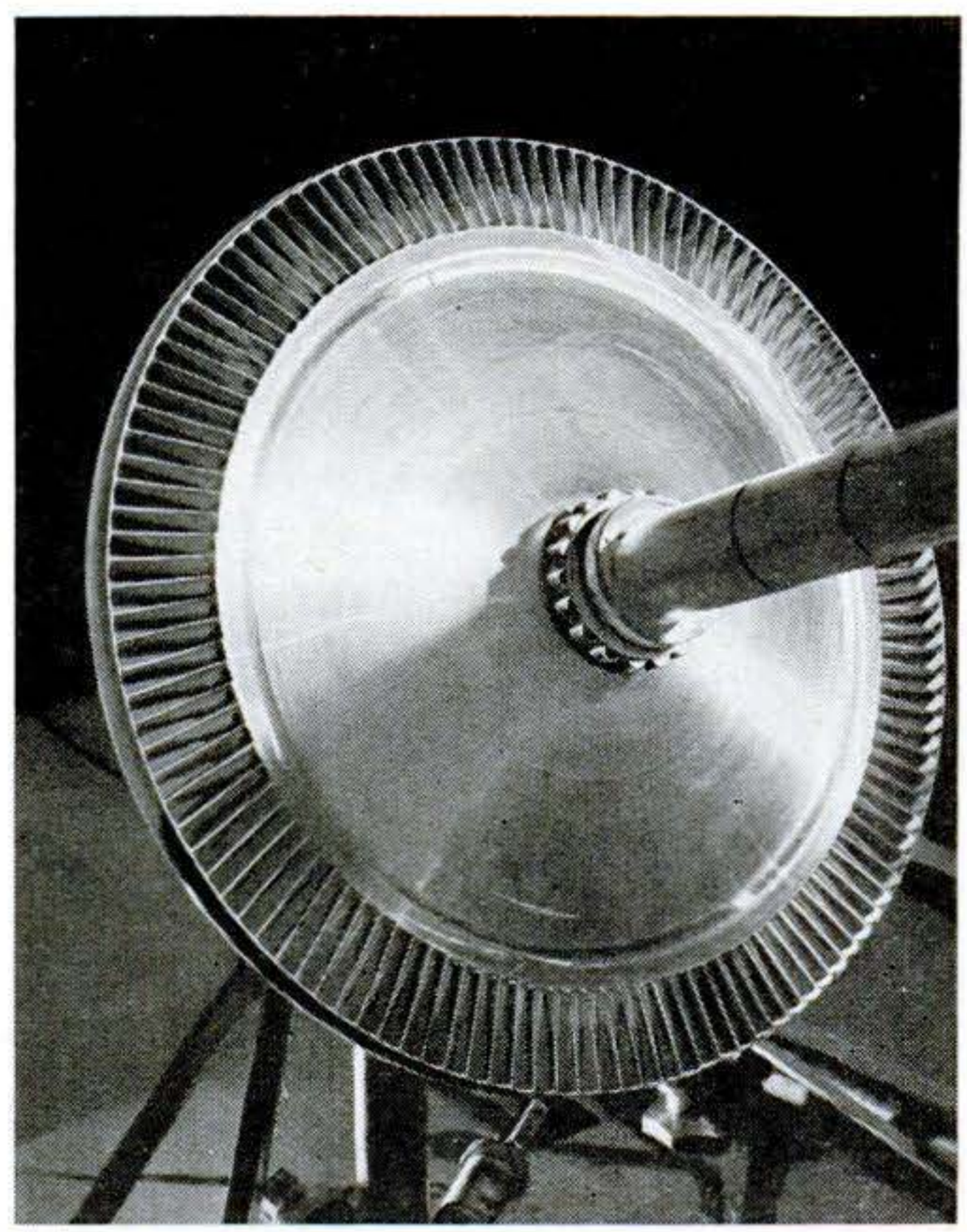
Turbines have simple mountings. This is the port suspension point—one of three—of the centrifugal I-40. Spark plug (lower center) in combustion chamber is used only to start combustion; flame is then passed on to other chambers, which ring the engine much like the cylinders on a radial reciprocating engine.



Turbine buckets are mounted on wheel with this toothed, wedge-shaped joint to help them withstand the tremendous centrifugal forces developed. These forces, plus constant peak temperatures, raise the weight-vs.-efficiency bogey in turbine refinements. Metal-rimmed ceramics are being tested as a possible answer.



Gases leaving combustion chamber, like the air passing through compressor, must be directed—but the gases are twisted instead of straightened out. This stationary nozzle ring imparts a rotary motion to gases as they pass through the angled vanes on its outer portion. Then whirling gases hit whirling turbine buckets.



Turbine of TG-180 consumes 4/5 of the energy in hot gases to provide power for compressor. One trick used to spare turbine the punishment of excess heat is "bleed-burn" cycle, in which air is bled off the compressor, routed around engine and into the tailpipe, where it is burned to obtain a higher temperature.

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turbojet is still so new that the experts can prove almost anything they want to about it with pencil and paper. They can show that it's no good for anything but short hauls; they can show that it's best for long hauls.

The conservatives among engine men are hooking the turbine to a propeller. That makes it fairly tractable. The turboprop is more responsive and more flexible than the pure turbojet. But it sacrifices the shining virtue of the jet engine—high speed. Then there are the middle-of-the-roaders. They combine turbojets with turboprops, even turbojets with piston engines.

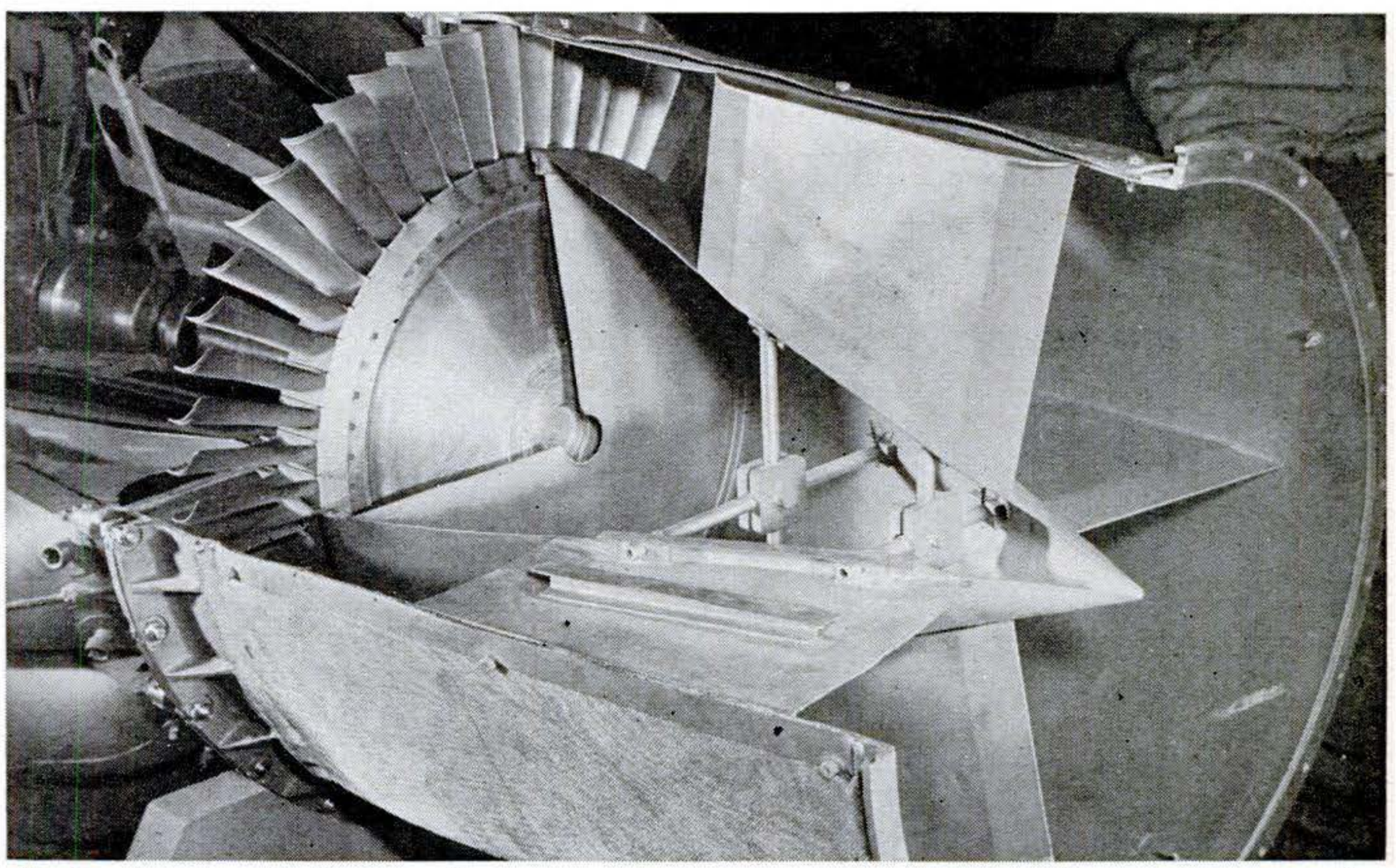
But the revolutionaries in the engine design business will have no part of turboprops. With all its faults, they want the turbojet. Months ago they experimentally wedded the turbojet, submerged in the body of a plane, to the pure ramjet, attached to wing tips (PSM, Feb. '47, p. 85). Now, as a next step, they've devised the after-burner.

Its principle, essentially the same as the steam-turbine reheat system, is fairly simple. This is how it works in an experimental engine developed for the Navy's Bureau of Aeronautics at the Ryan Aeronautical Co. in San Diego, Calif.: A high temperature is developed in the engine proper, but this drops at the turbine exit, where the gases are slowed down by diffusing them through a conical section of the tailpipe. The after-burner is, in effect, an extension of the tailpipe. The burner assembly itself consists of six spokes bearing two rings. Each ring has scores of tiny holes through which fuel emerges.

Automatic Action

The tricky part of the burner is its automatic response to gas temperatures in the tailpipe. When a pilot wants extra thrust, he turns on his after-burner. The burner will operate in the presence of the normal temperature drop, but will shut off by itself if the additional fuel shoots the temperature to the danger point.

As a boost for turbojet thrust, the after-burner outdoes itself. From about 600 miles an hour up through the transonic range, it is expected to double the jet power. Then, however, the combined thrust drops off somewhat, and it is estimated that at twice



All that has gone before is only a preparation for turbojet's end product—the blast at its stern. Cutaway of barrellike tailpipe shows cone for directing gases. Cone's light supporting structure and pipe itself are surrounded by a heat-diffusing screen blanket. Heat exchangers have been proposed as a means of saving some of the energy a jet spews into the air. One suggestion is to heat the incoming air before it is mixed with fuel by routing it ring-around-the-rosy from compressor through tailpipe. A similar trick is used in military rockets, where fuel cools the combustion chamber while the chamber is preheating the fuel.

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the speed of sound the burner will be delivering all the power. The turbojet will become a parasite. At that speed, says Dan Sanborn, Ryan engineer primarily responsible for the refinement of the afterburner, "It is better to by-pass the jet engine and fly on the after-burner."

Aid for Take-Offs

At the other end of the speed scale, the after-burner may eventually be used to provide added thrust for take-off in jet transports. The gas turbine is essentially a constant-speed engine, and the jet itself is efficient only when the speed of the plane mounts toward the speed of the gas. That makes it sluggish on take-off, and if a pilot reduces throttle in flight, it takes several seconds to regain speed after the throttle is opened again. Extra thrust would help solve those problems.

Experiments are also going on with varying the size of the tailpipe aperture to slow down and speed up the velocity of the gas at the will of the pilot. Some research men think that the turbojet will come to incorporate ducted fans. That means capturing additional air, boosting its velocity as it flows around (instead of through) the engine, and shooting it out the back for added thrust. The ducted air wouldn't go as fast as the turbine gases, and would provide more propulsive efficiency at low speeds.

While these construction puzzles are being kicked around, the turbojet is creating an ever-lengthening list of problems for the airplane designers. One of them recently was discussing what the new power plant would do to the weight and shape of tomorrow's aircraft.

"The power-for-weight ratio of the turbine engine," he said, "should permit lighter aircraft structures. Instead, it probably will dictate heavier ones because of the stresses produced by the jet's speed.

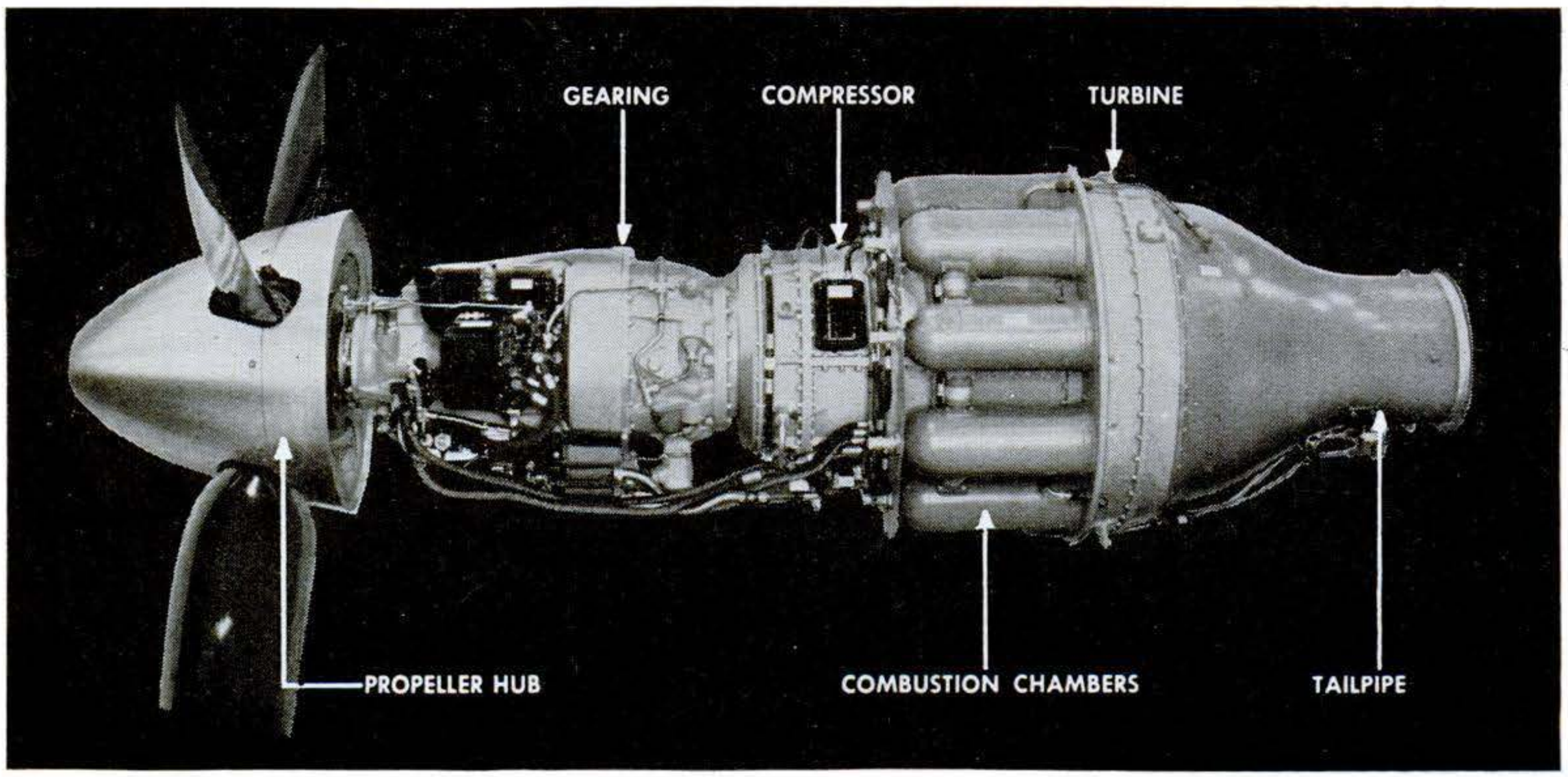
"Jet transports will fly at great heights for minimum air resistance and consequent fuel economy, but they will still be subject to severe updrafts and downdrafts. If passengers are going to have a safe ride, airplane wings must have enough lift to take off and land at reasonable speeds."

He sighed. "But if they're going to have an easy ride, we've got to rob the wings of some of their lift, at least at high speeds, to cut down the viciousness of the air bumps."

They Won't Wait

That's only the beginning. Jet transports will fly between 400 and 500 m.p.h. They will gulp huge quantities of fuel. In thick weather, an airport control tower won't be able to "stack" jet transports, as it does piston-propeller aircraft, to circle in the clouds until they can be brought down conveniently. The jet won't have the reserve

Turboprops like this TG-100 represent an effort to overcome jet's inefficiency at low speeds. Turboprop efficiency rivals that of piston-propeller unit, but gearing is a problem.



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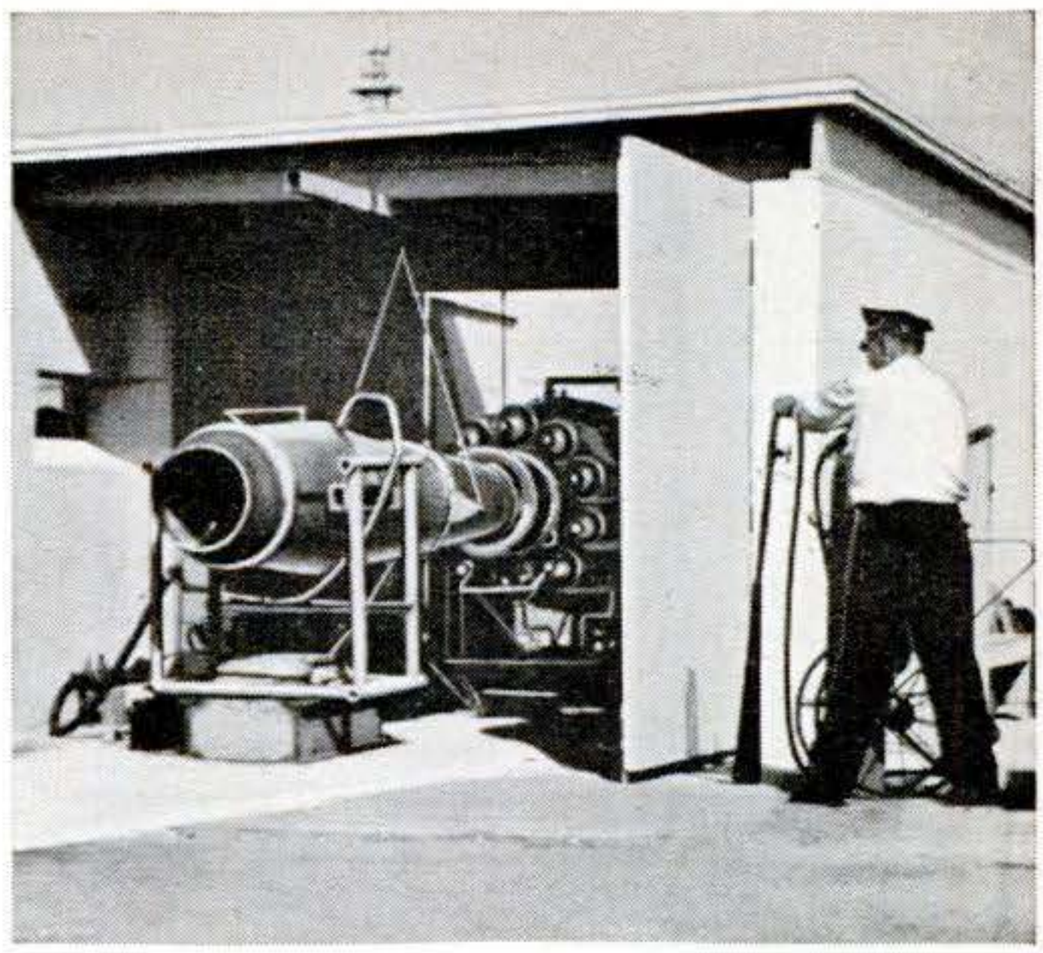
fuel. When a jet transport pilot gets his clearance to take off from Chicago, he will have to be handed his clearance to land at Kansas City or New Orleans.

One suggestion to save fuel is to have jet air liners towed from the passenger loading ramp to the runway by special tractors. That also would solve the problem of wearing out the wheel brakes in keeping the rapidly turning turbines in leash on the ground. Jet planes could take off as soon as the tractors unhanded them, since turbines require no warm-up.

New Rules for Old

It may be that jet transports will require their own airports at major cities. Trying to fit them into a normal traffic pattern with slower aircraft will be difficult, if not dangerous. Similarly, jet transports will require a whole new set of airway rules. Sheer speed will dictate the jet's monopoly of the right of way. And directing the movement of aircraft covering eight miles each minute will call for a sophisticated traffic control system, not to mention a foolproof radio navigation system.

But if any of these problems sound insurmountable, that's merely another of the turbojet's contradictions. An affair between the turbojet builders and the makers of transport planes is beyond the flirtation stage. The plane designers want jets now. One of them told *Popular Science Monthly:*

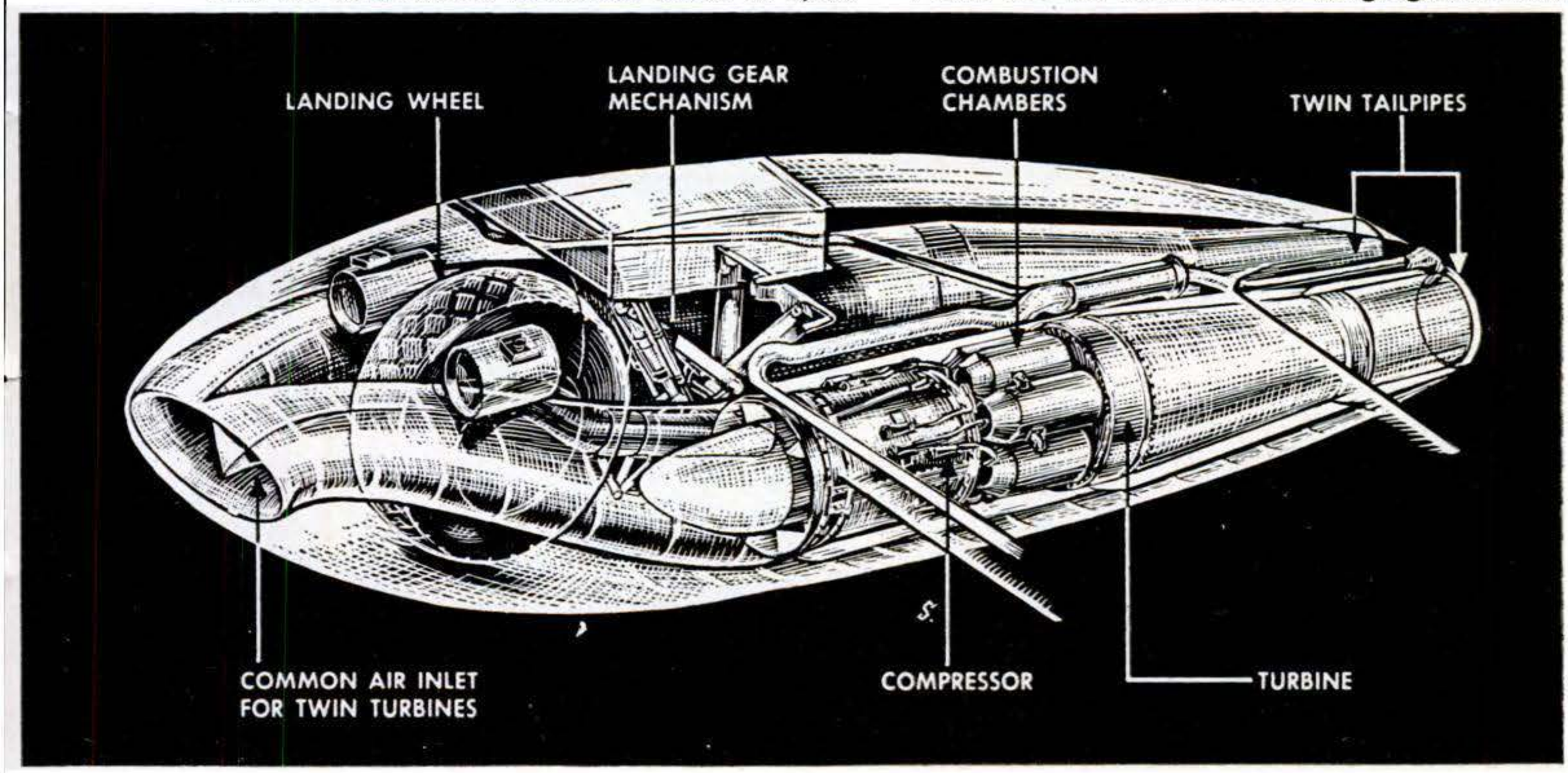


An afterburner at work. Undergoing tests at Ryan plant, this stinger in a turbojet's tail will boost fighter's speed, may answer some problems involved in operating jet transports.

"We're ready to go ahead with a jet transport. We don't see any reason for fiddling with turboprops as an intermediate stage." Every major transport manufacturer in the United States has plans for a jet air liner under his desk blotter.

The Army Air Forces will specify jet propulsion for more than six out of every 10 airplanes it orders in 1948. One international authority gives the piston engine for military and transport aircraft only 10 more years of life. END

Jets permit streamlining hitherto impossible. Two TG-180s with a combined thrust of 8,000 lb. share a snug berth in nacelle of Consolidated Vultee XB-46. Steel shrouds wing against heat.



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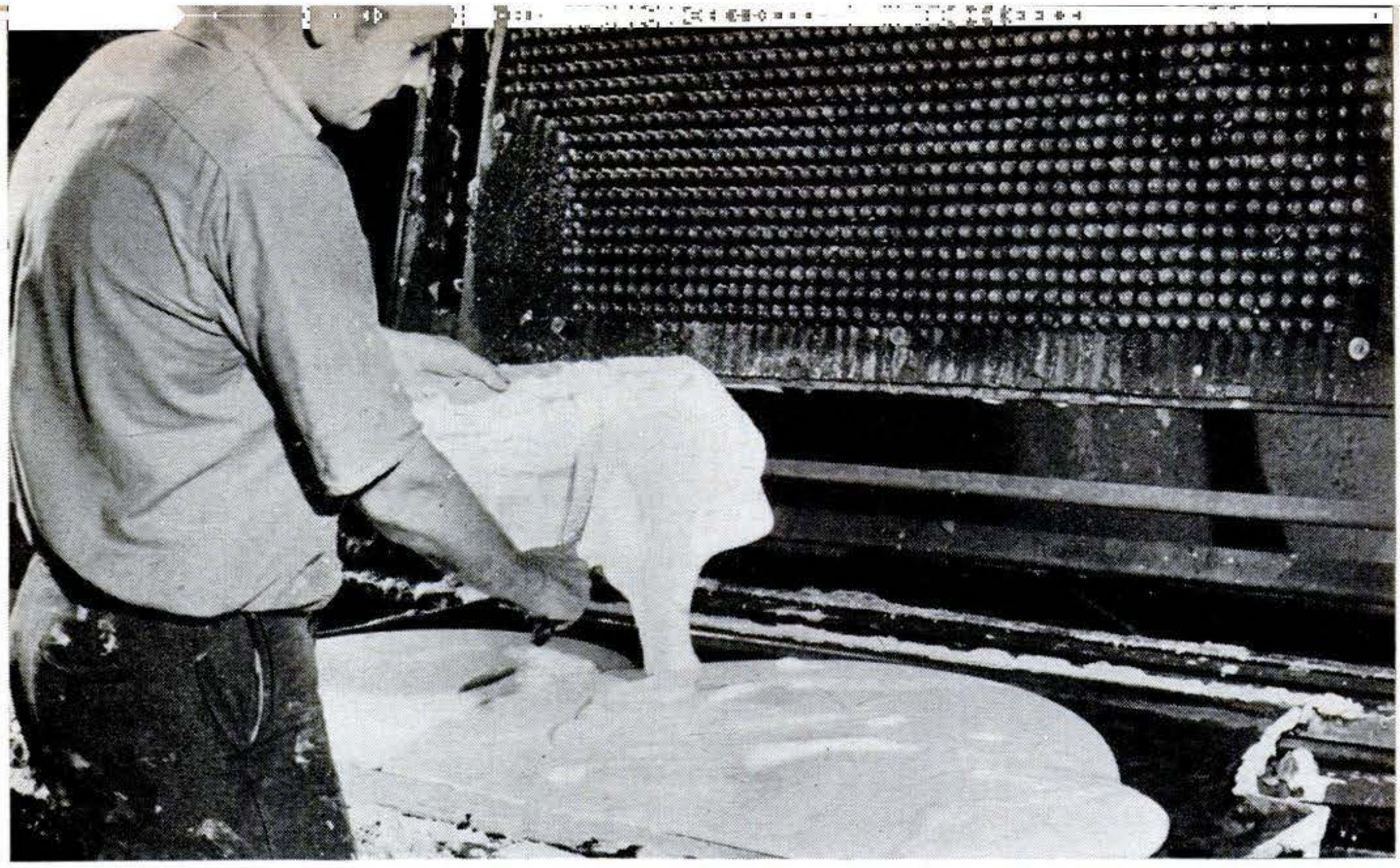
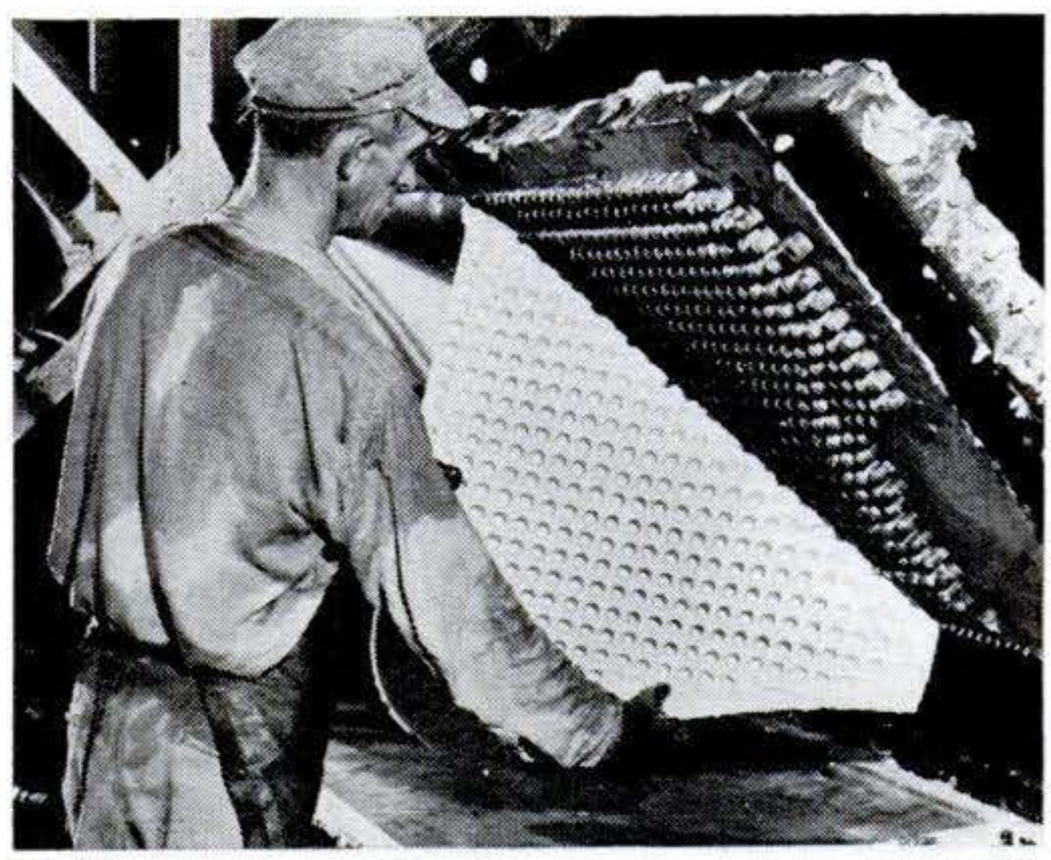


Spread in "waffle iron," milklike latex is molded into foam-rubber cushion for auto seat.

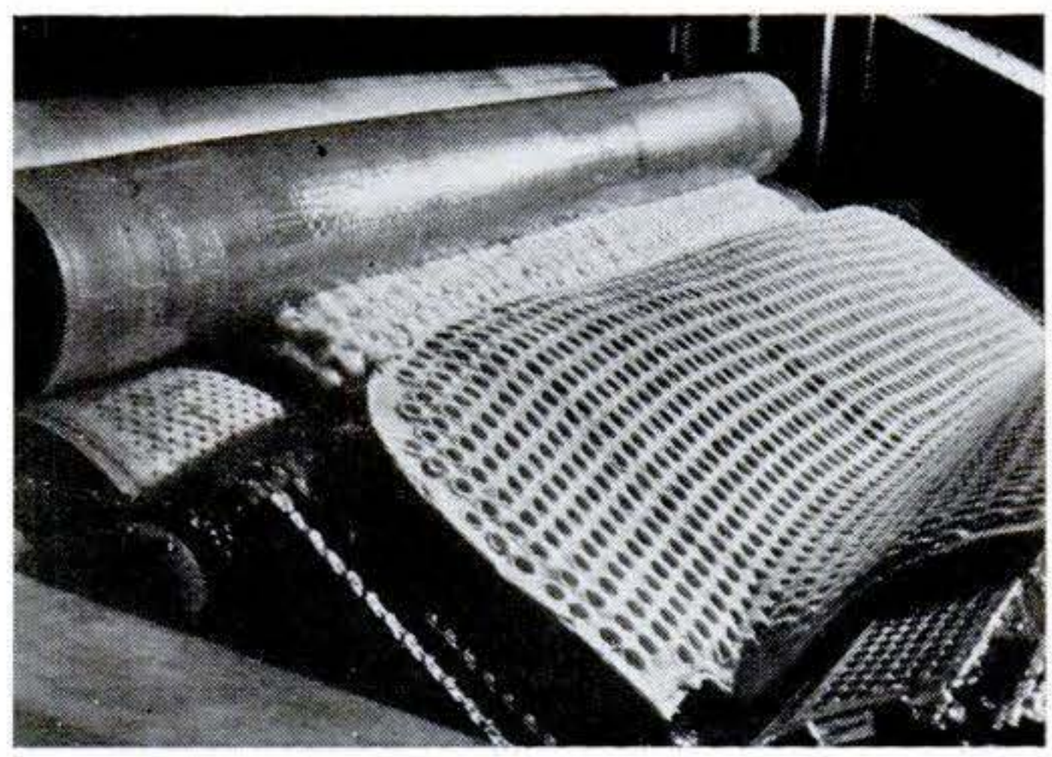
"Waffle Iron" Makes Cushions Of Foam Rubber

WAFFLES of rubber, "grilled" in molds resembling giant kitchen utensils, make comfortable upholstery padding that does not lose its resiliency. Production of foam-rubber automobile seat cushions and train seats, interrupted by the war, has now been resumed at the Mishawaka, Ind., plant of the United States Rubber Company. Featherweight mattresses of the same material, easy for any housewife to straighten or lift from a bed, will soon be available.

Millions of air bubbles whipped into the raw material—milky latex from Malaya plantations—give the foam rubber its light weight and flexibility. Seasoned with a dash of chemicals, the mix goes into a mold and is popped in an oven for a baking that vulcanizes the rubber and imparts its permanent shape. Thoroughly washed to remove chemicals and soaps, the product emerges clean and odorless from a drier.



Baking cures rubber, and opened mold yields springy cushion of desired size and shape. Foam-rubber upholstery padding is standard in many makes of cars, optional in others.



Wringer removes excess moisture after copious washing. Final treatment is several hours of low heat in a drier. Comfortable foam-rubber cushion has lasting resiliency.

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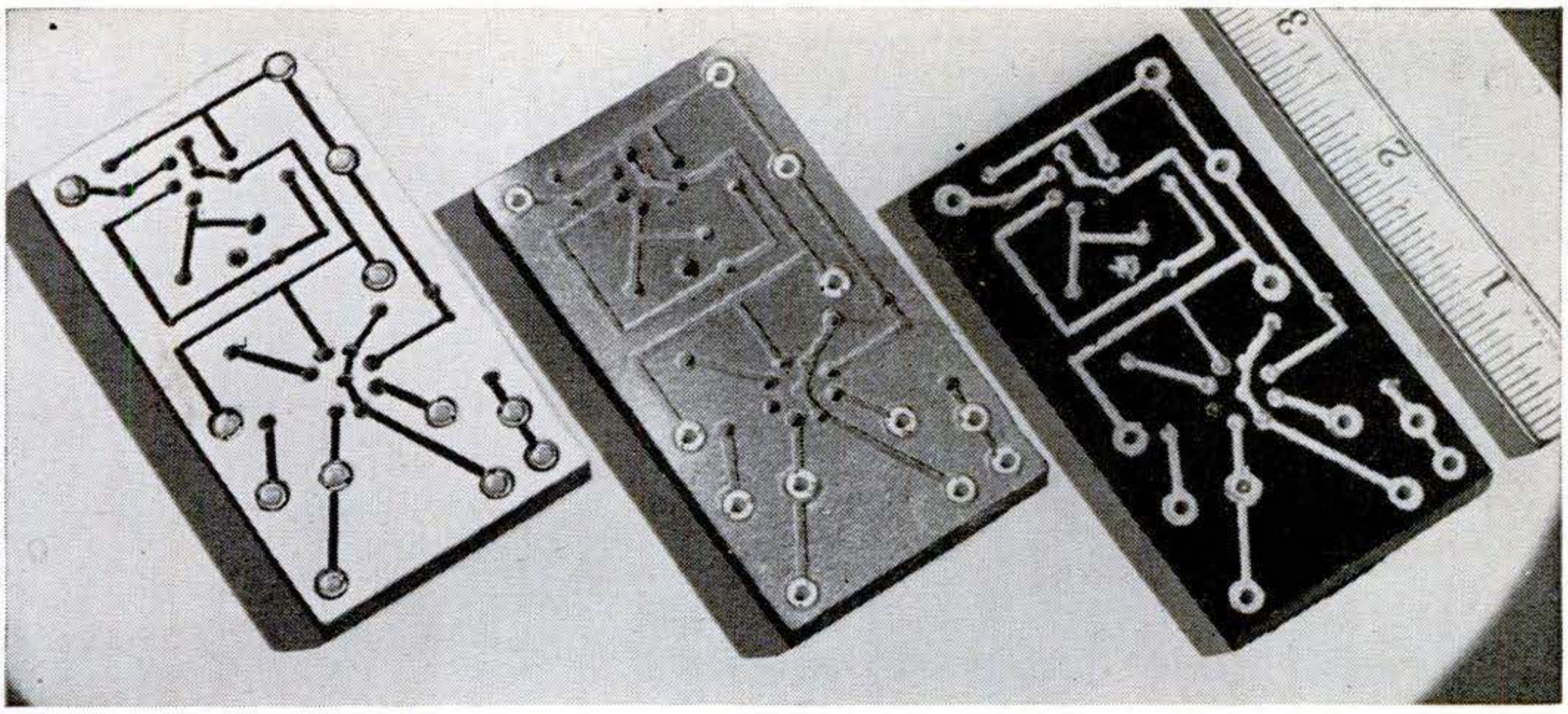


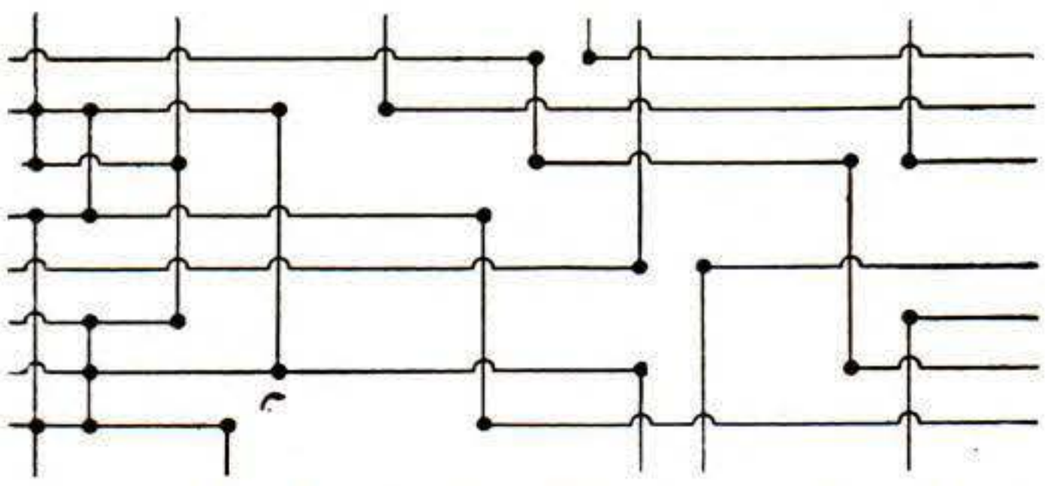
Progress of sprayed circuit. Left to right, plastic base with stencil in place; base with grooves sandblasted in; base with grooves filled with sprayed metal, completing the circuit.

Wireless Wiring for Radios

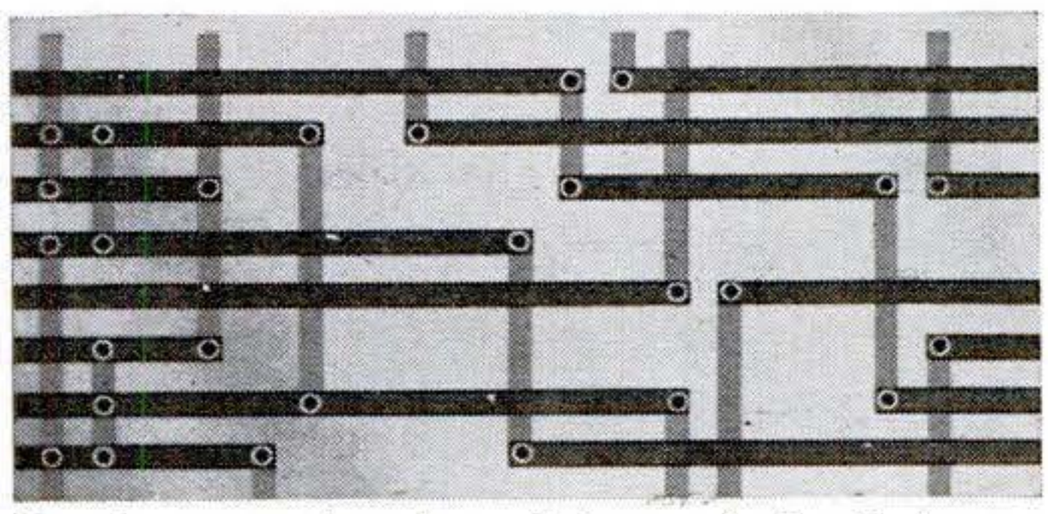
THAT repairman's headache, the jumble of wires on the bottom of a radio, may join crystal sets in the museum. Two new processes mass-produce neat circuits, easy to check for trouble. They promise to do for average radios what printed circuits (PSM May '46, p. 131) are doing for miniatures.

In a system invented by A. M. Hathaway and developed by Spraywire Labs. of Minneapolis, a plastic panel is covered by a Scotch-tape stencil of the circuit. Through this, grooves are sandblasted, then spray-gunned full of atomized metal. Two guns can spray more than 1,000 units an hour.

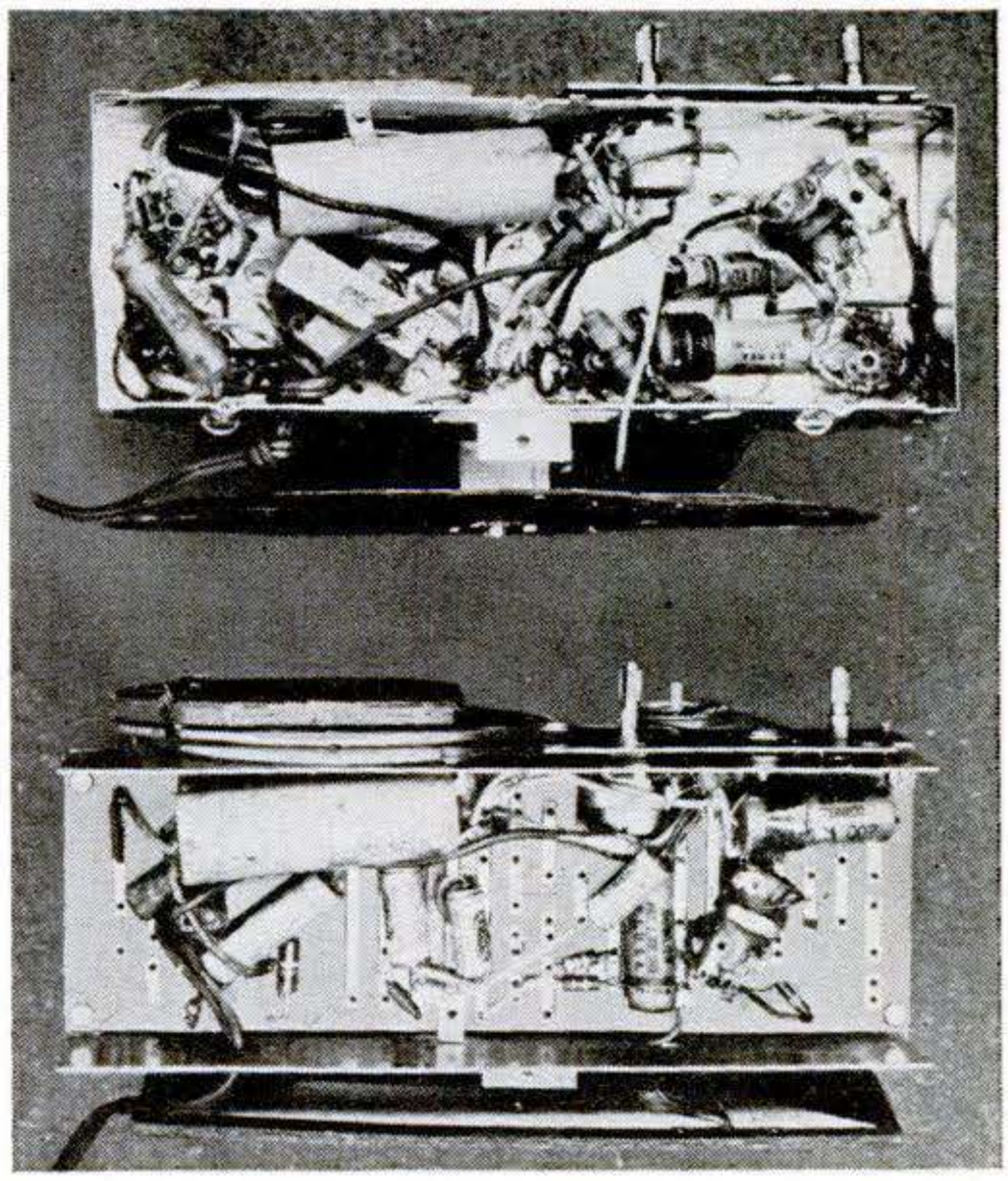
Another method uses two copper sheets on opposite sides of an insulating panel. All horizontal parts of the circuit are stamped out in strips on one side: vertical on the other. The two are connected by metal eyelets punched through the panel.



Conventional circuit diagram (above) as drawn by an engineer is duplicated by the stamped circuit below, developed by A. W. Franklin Mfg. Corp., of Long Island City, N. Y.



In phantom drawing of stamped circuit, heavy lines represent metal strips on top of base; light lines, strips beneath. Eyelets connect them.



Usual rat's-nest wiring of conventional radio is at top: below, the same thing using neat, easy-to-maintain circuit produced by stamping.

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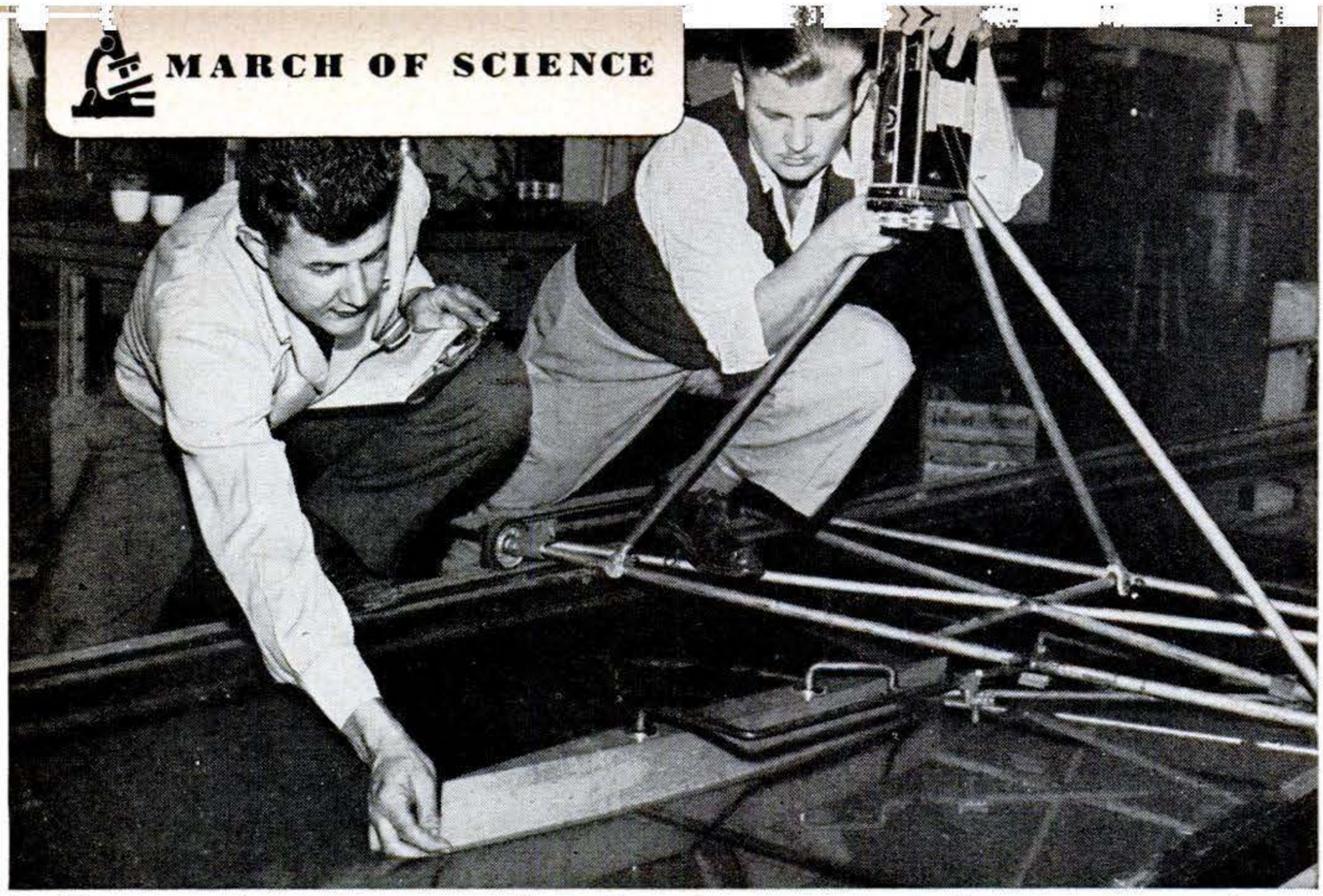
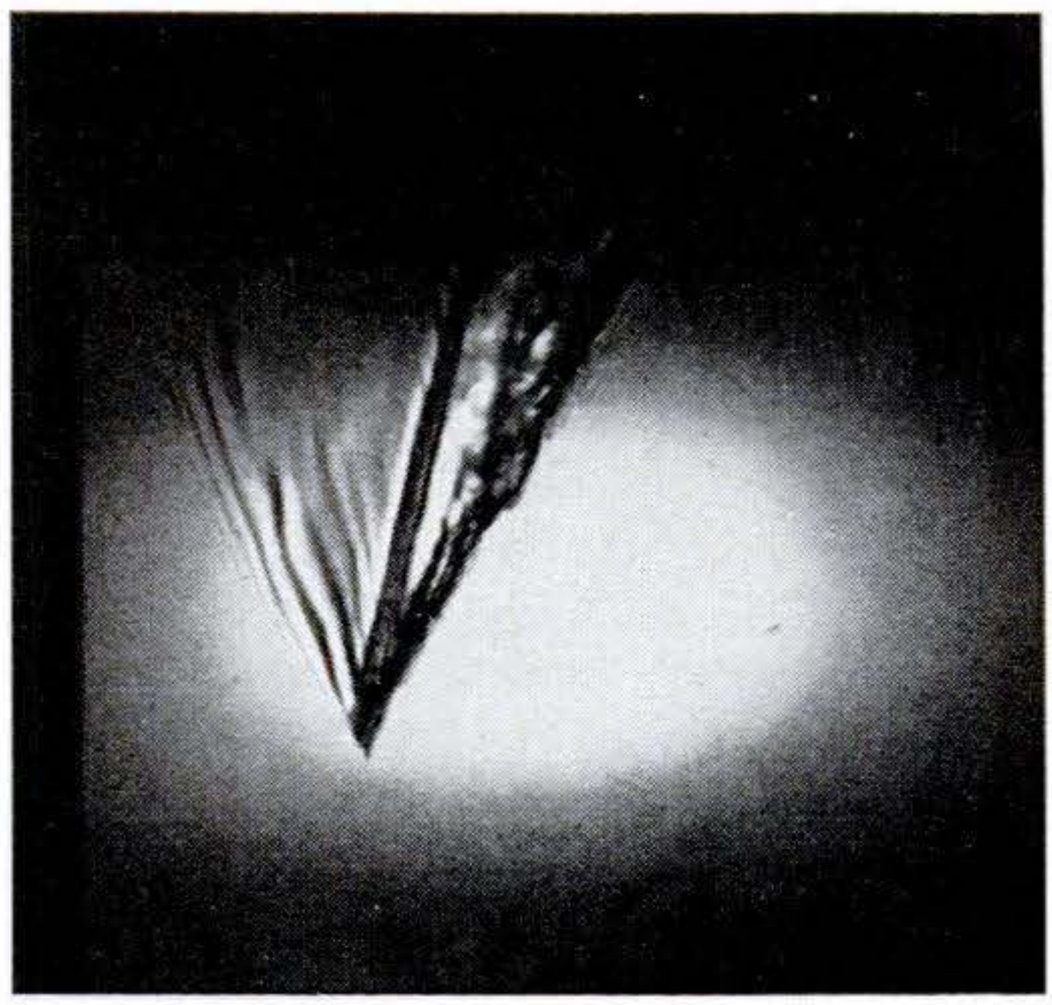


A 35-mm. movie camera, mounted on the wheeled stand that propels the model through the water, records the wave patterns of a supersonic wing. Water here is quarter-inch deep.

Trough Tests Superspeeds

WITH a shallow trough of water, engineers can now study shock-wave patterns of speeds far faster than that of sound. Towed models of wings or other plane parts set up water-wave patterns similar to their shock waves at supersonic air speeds. The water is from 1/10 to one inch deep; the shallower it is, the greater the simulated speed. Engineers at North American Aviation say the water tests are not only cheaper than a supersonic wind tunnel, but can also be used to study accelerated motion.

These rounded waves are produced by the equivalent of 970 m.p.h. Actually the nose of the 10-inch plate, set at a 12° angle, passes through an inch of water at 2.2 feet per second.



Decreasing water depth to 1/10 inch, while keeping actual motion constant, produces this 3,150-m.p.h. shock-wave pattern for the same model. At right, wave now hugs plate.

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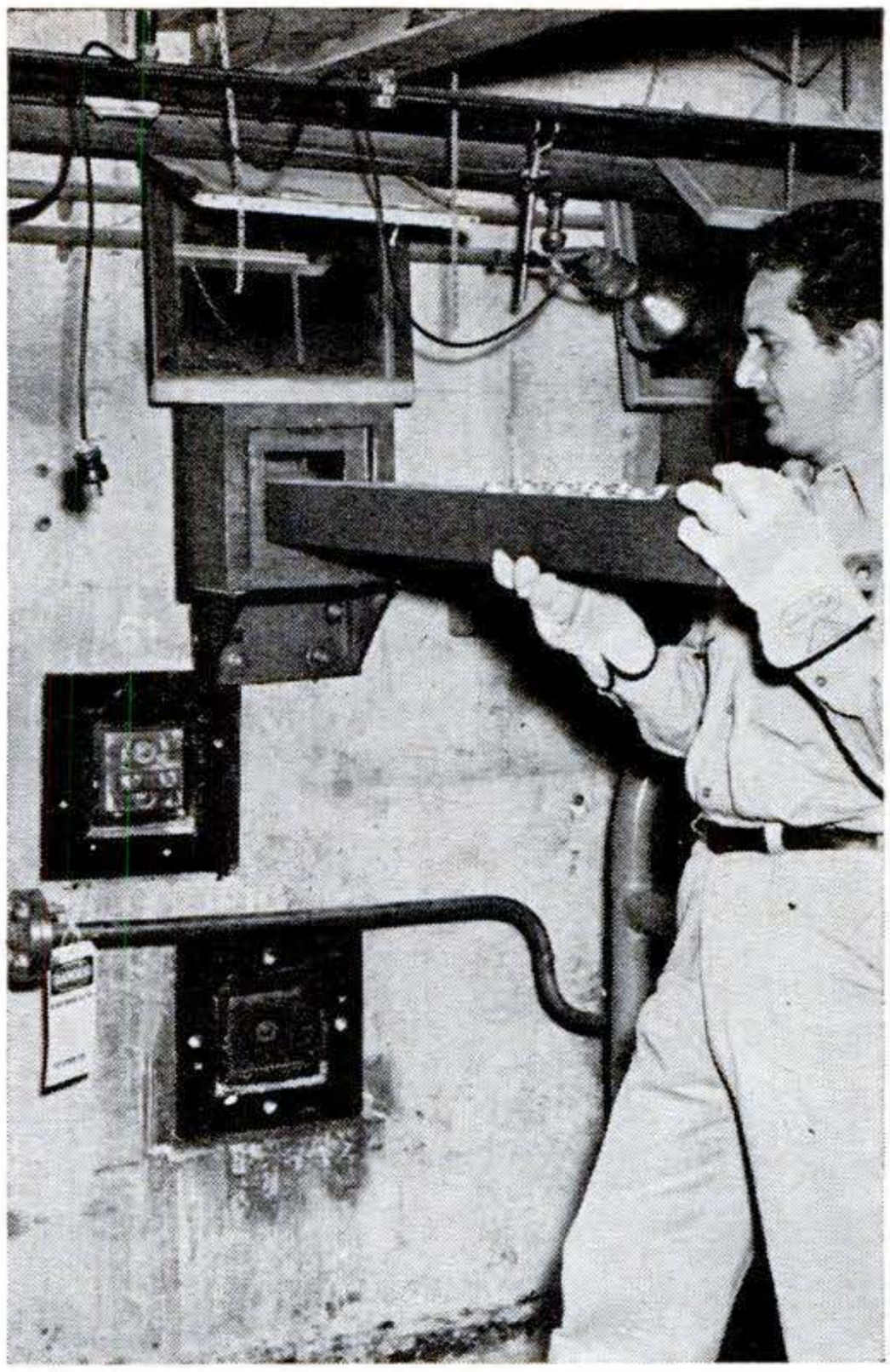
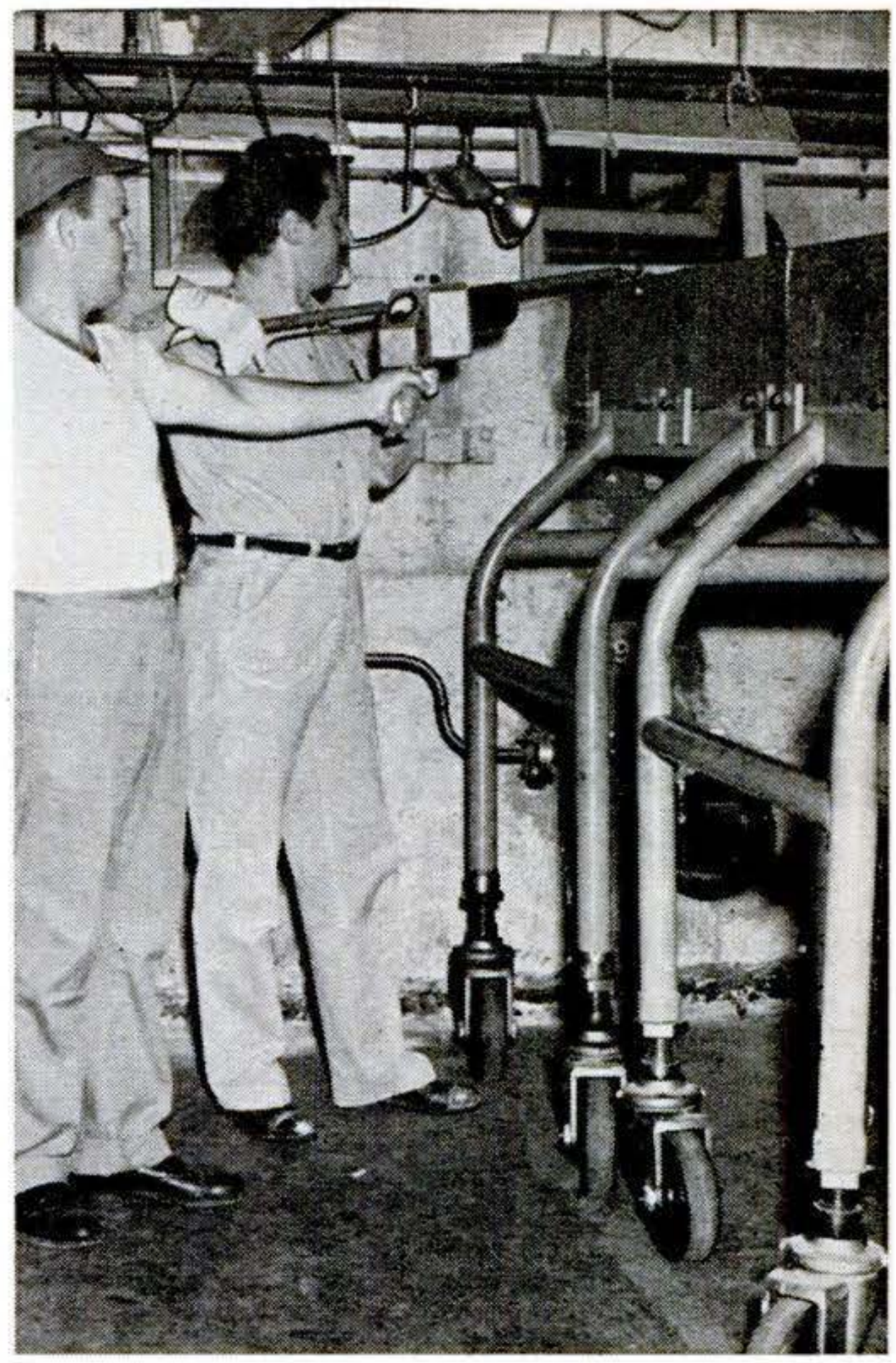


No shielding is required when chemicals are put in the Oak Ridge pile to be irradiated. Chain reaction has been stopped; will not restart until charge hole is again closed.



Taken from the pile, material is now dangerously radioactive. Worker at left holds radiation meter for safety check. Material—gold—will be put in heavy lead shields at right.

Shipping Radioisotopes

RADIOISOTOPES, beneficent children of the deadly atom bomb, are now offered by the United States to scientists in every country, to promote international research in medicine and technology for the good of all mankind. In the year since the government placed them on domestic sale, more than 1,000 shipments have been made to 160 American hospitals and research centers. They require special precautions in handling, and speedy shipment before they lose their strength. Those of shortest life travel by air.

The chemicals are made radioactive in the uranium chain-reacting pile at Oak Ridge, Tenn. They make ideal research tools since, while chemically the same as their ordinary counterparts, the rays they emit permit them to be traced through the body or batches of industrial chemicals.

For shipment, a bottle of radioactive iodine must be placed inside two-inch lead shield. Worker handles it with long strings so as not to expose himself to too much radiation.

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Aboard a tree planter hitched to a tractor, operator lifts seedlings from storage boxes and drops them into furrow made by hollow plow. Furrow depth is controlled by weights on plow.

Plow Plants Trees

Two men can put in 10,000 seedlings a day with the new Lowther Tree Planter. Tractor-drawn, it is designed for restocking rough, cut-over land. The Harry A. Lowther Co., of Chicago, says it is 50 to 80 percent cheaper than hand planting.

A heavy disk cuts a nine-inch-deep slit in the earth. A plow following right behind it enlarges this to a furrow two inches wide. The operator, seated at the rear of the planter, then drops a sapling into the open furrow through the hollow shoe formed by the back of the plow. As the plow moves ahead, the earth drops back around the tree and is packed down by the two rear wheels, which pass close on either side.

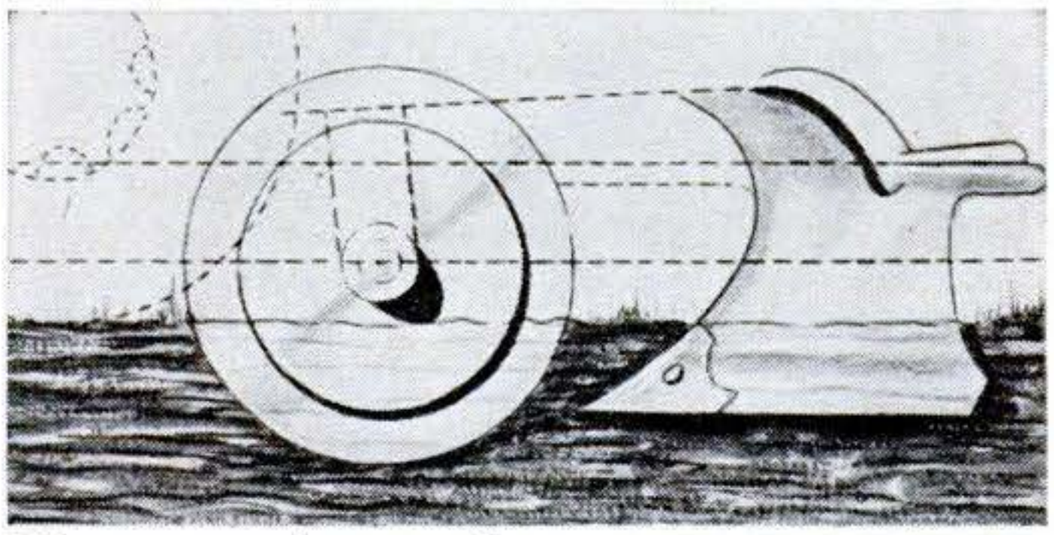
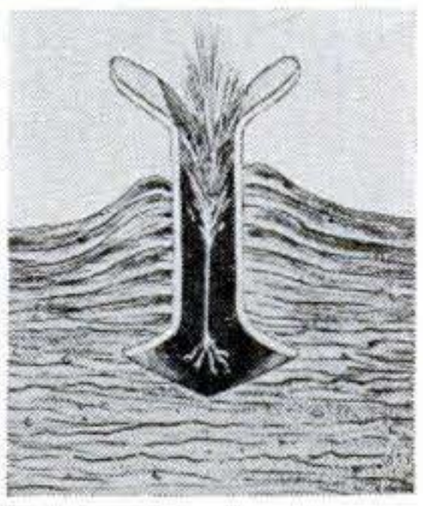


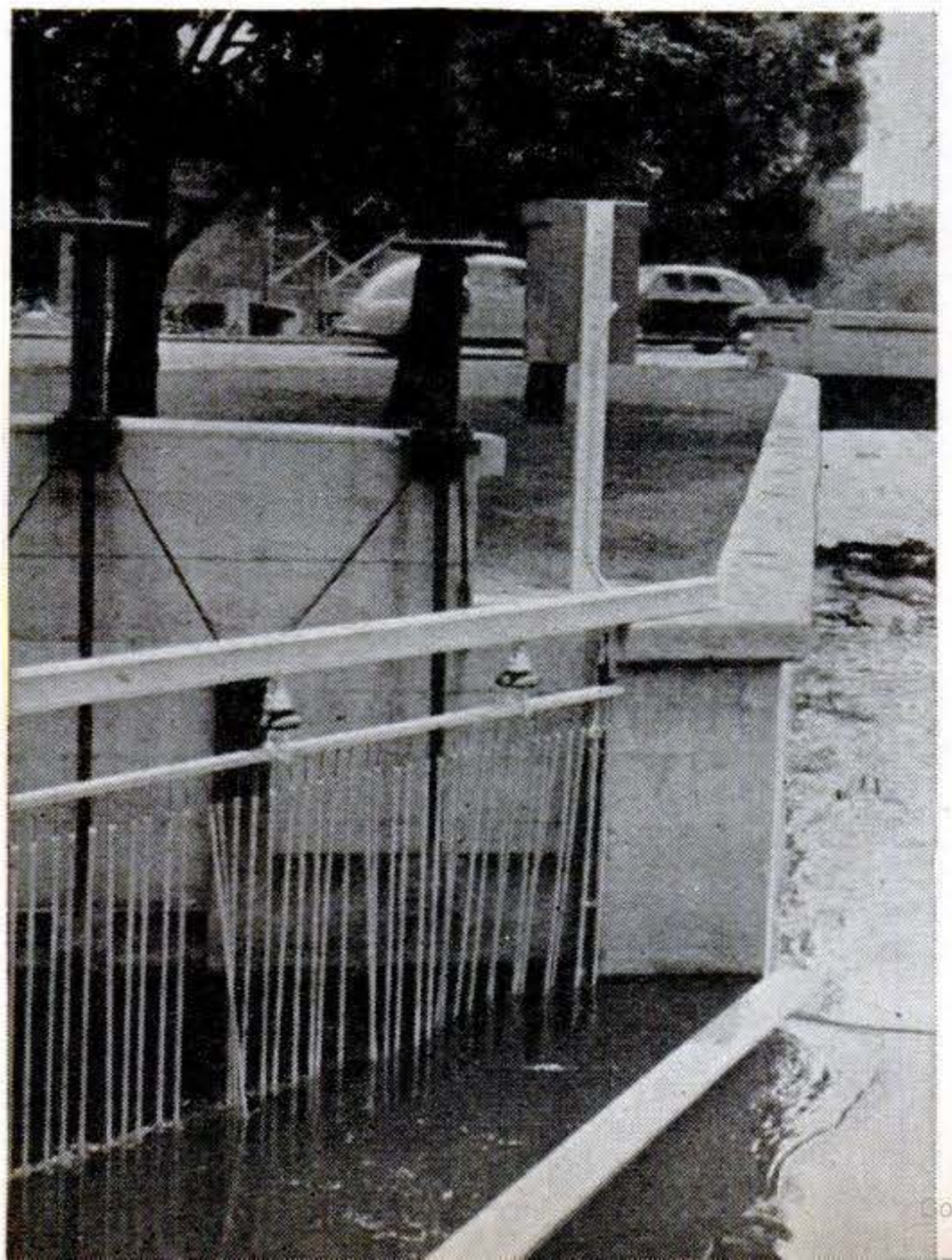
Diagram above, shows how 28-inch disk coulter prepares cut for plow. Disk cuts through 2½-inch roots, rides up over larger obstacles, lifting plow at same time. At right, cross section shows how plow lifts and spreads earth for planting furrow. Wings guide trees into furrow.



Fence Shocks Fish

Out in California, foolish fish who try to swim into irrigation ditches are going to get the shock of their lives. A marine version of the electric cattle fence keeps fish out—without hurting them—while passing water or debris. Shown at right, it consists of a free-swinging row of electrodes, connected to a generator. The electrodes slightly charge the water around them.

Invented by Henry T. Burkey, of Hollywood, Calif., the fish screen uses a generator he developed jointly with Westinghouse. Nettings in California have shown that at times as many as 25,000 salmon have been lost in a single irrigation ditch in a 24-hour period. Hydroelectric plants and industrial pumps are other hazards.



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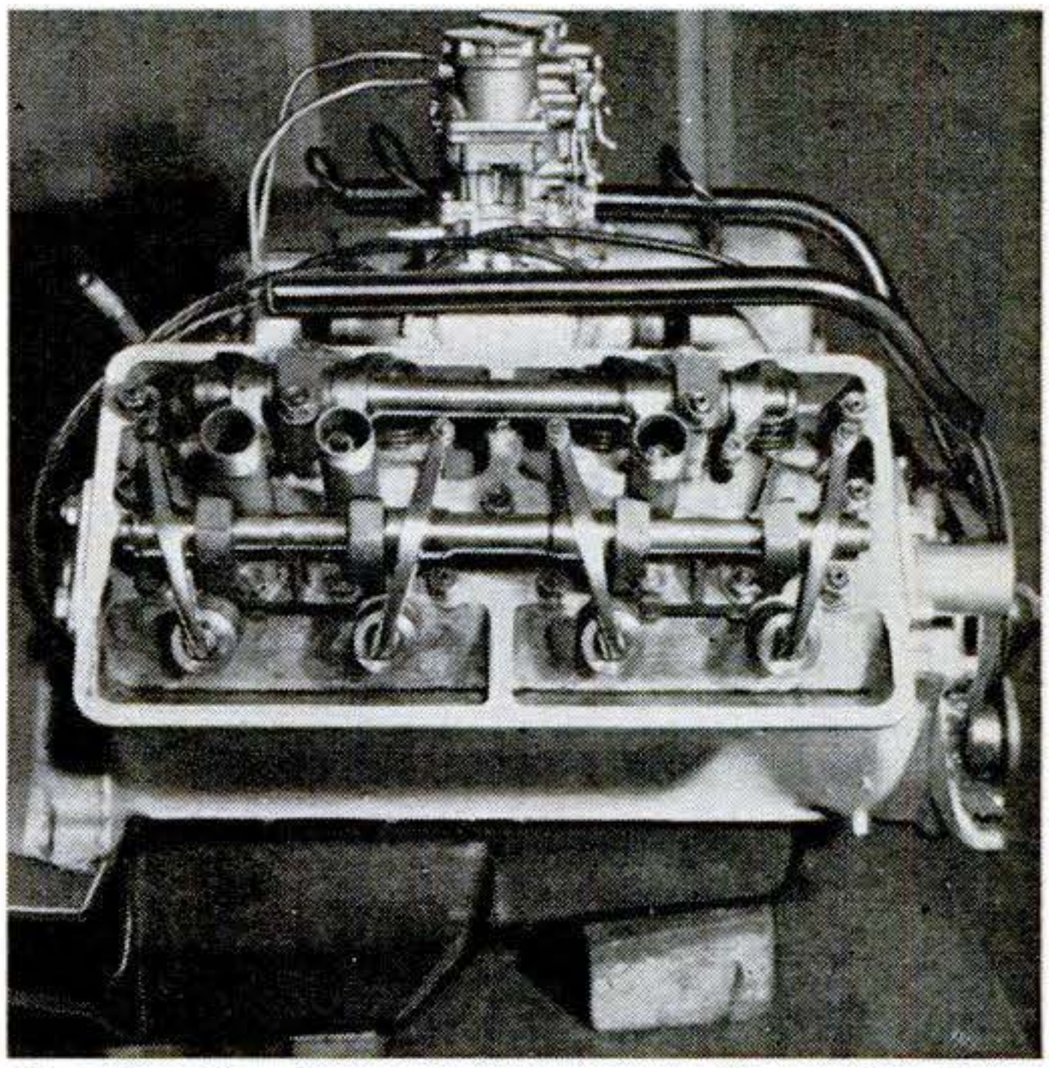
Aircraft Power Put in Trucks

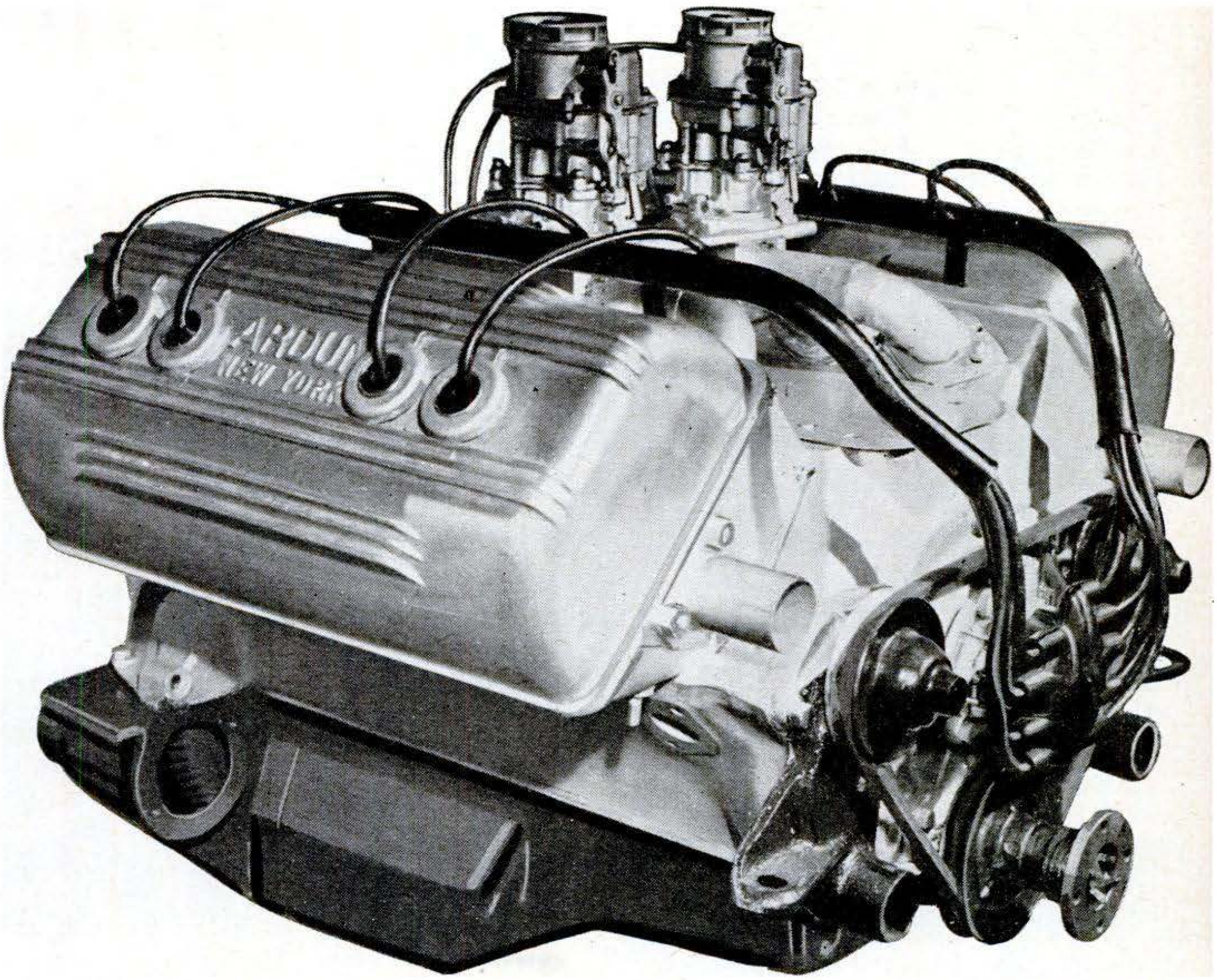
DESIGNED to blend aircraft-engine efficiency with automotive-engine ruggedness, a new power plant for trucks has been developed by the Ardun Mechanical Corp., of New York, after two years of engineering experiments.

The engine is a V-8 patterned after a Ford truck motor—90 percent of its structural parts are said to be standard Ford items—but it has been considerably modified. Aircraft-type cylinder heads give it hemispherical combustion chambers, and it has larger, overhead valves to streamline the fuel-air mixture's path and improve the engine's efficiency.

These modifications, according to the builders, assure higher power output at the lowest price per horsepower of any similar engine now available. An engine normally rated at 100 hp. is said to deliver 160 hp. at the same operating speed, with a peak of 175 hp. at 5,200 r.p.m.



Overhead valve arrangement, shown in close-up with cylinder head removed, employs inclined push-rods and angled rocker arms. Four earlier models were tried out during research.



Engine's major parts are made of aluminum and alloy steels, both reported available for use.

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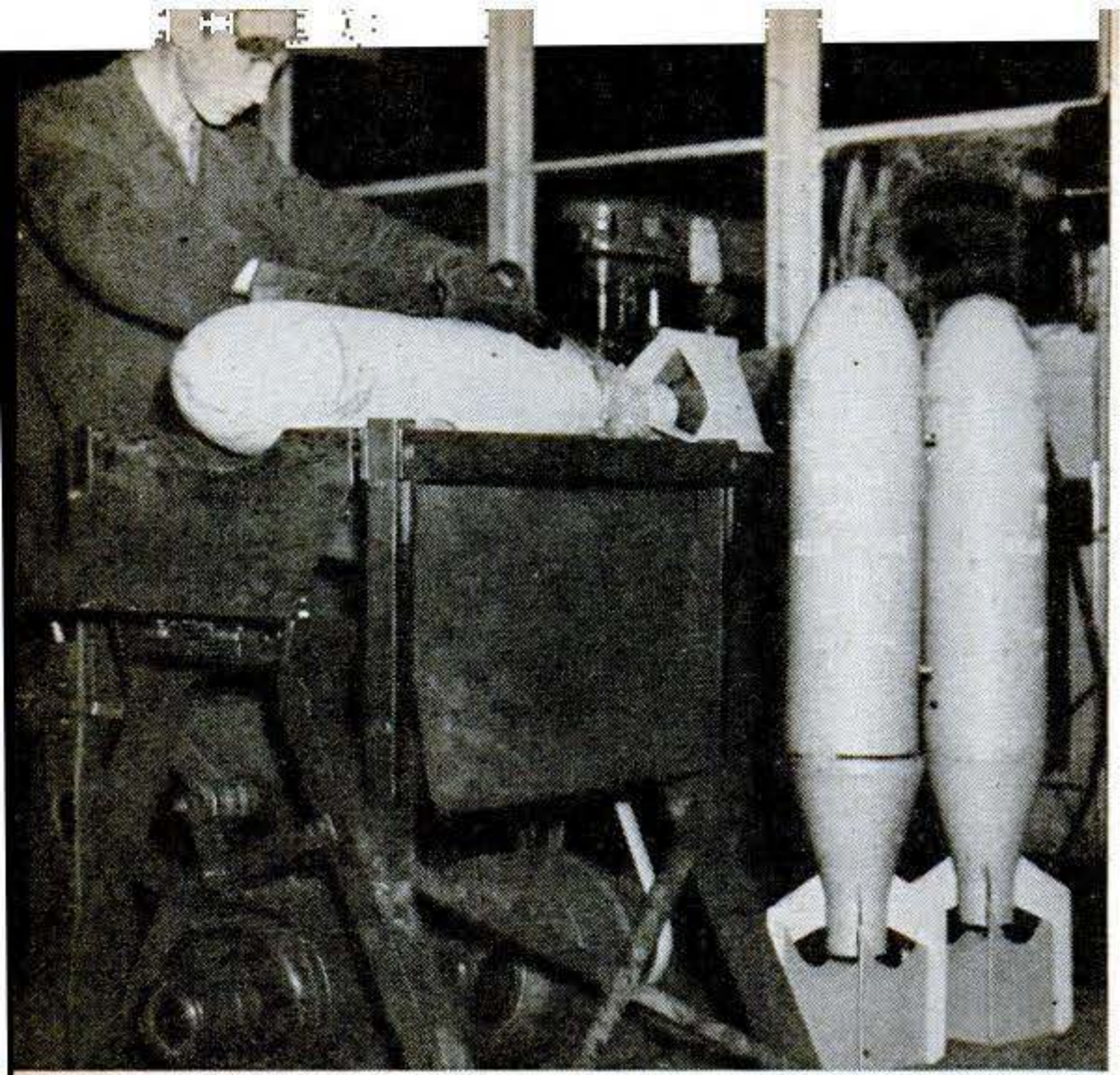
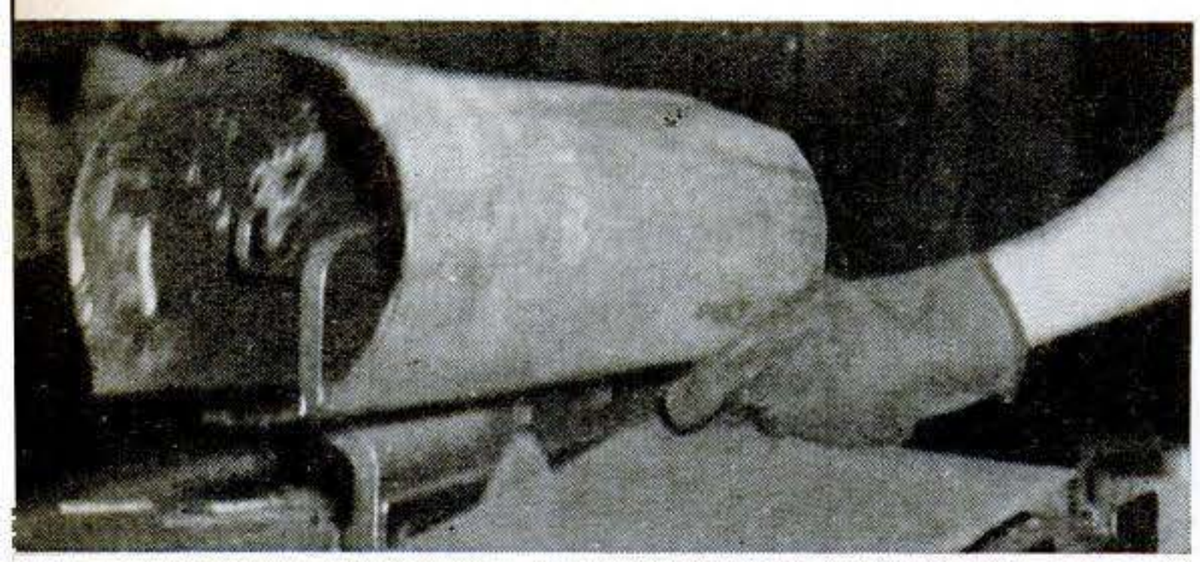


First step in turning bombs into mufflers at the Bruck Ordnance Depot is to remove the nose and tail sections of the practice missiles. A special cutting wheel does the job.

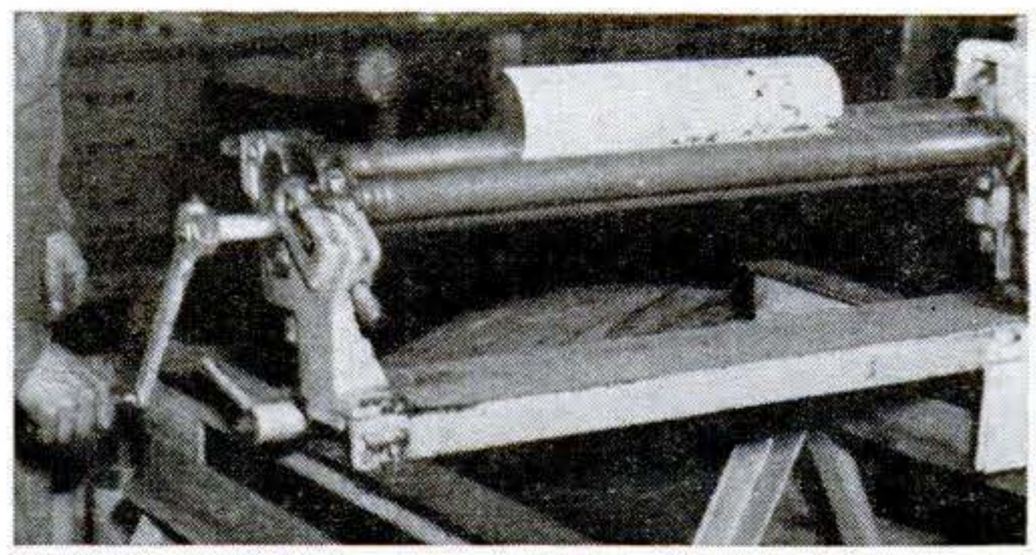
Beating Bombs Into Mufflers

PRACTICE air bombs, left over from the war, are being converted to a peacetime job. Air Forces trucks and autos in Germany urgently need mufflers, so the Bruck Air Ordnance Depot at Nuremberg is making them from surplus bomb stocks.

The project, started late in 1946, has already turned out more than 4,600 truck mufflers. Now the production line is well into an order for 2,200 jeep mufflers. Capacity is 600 of these a week.



After the metal skin of the bomb has been taken off, it is sliced and flattened into a metal sheet. Plant has regular production line.



The flat metal sheet, formerly the bomb casing, is now cut to size and rolled through this machine to shape it into the muffler's outer shell.

This machine draws the steel cylinders that form the outer casing of the mufflers into final elliptical shape. They still carry bomb label.

Last step in making muffler from bomb is to weld the component parts together. This soldier-welder is surrounded by finished units.

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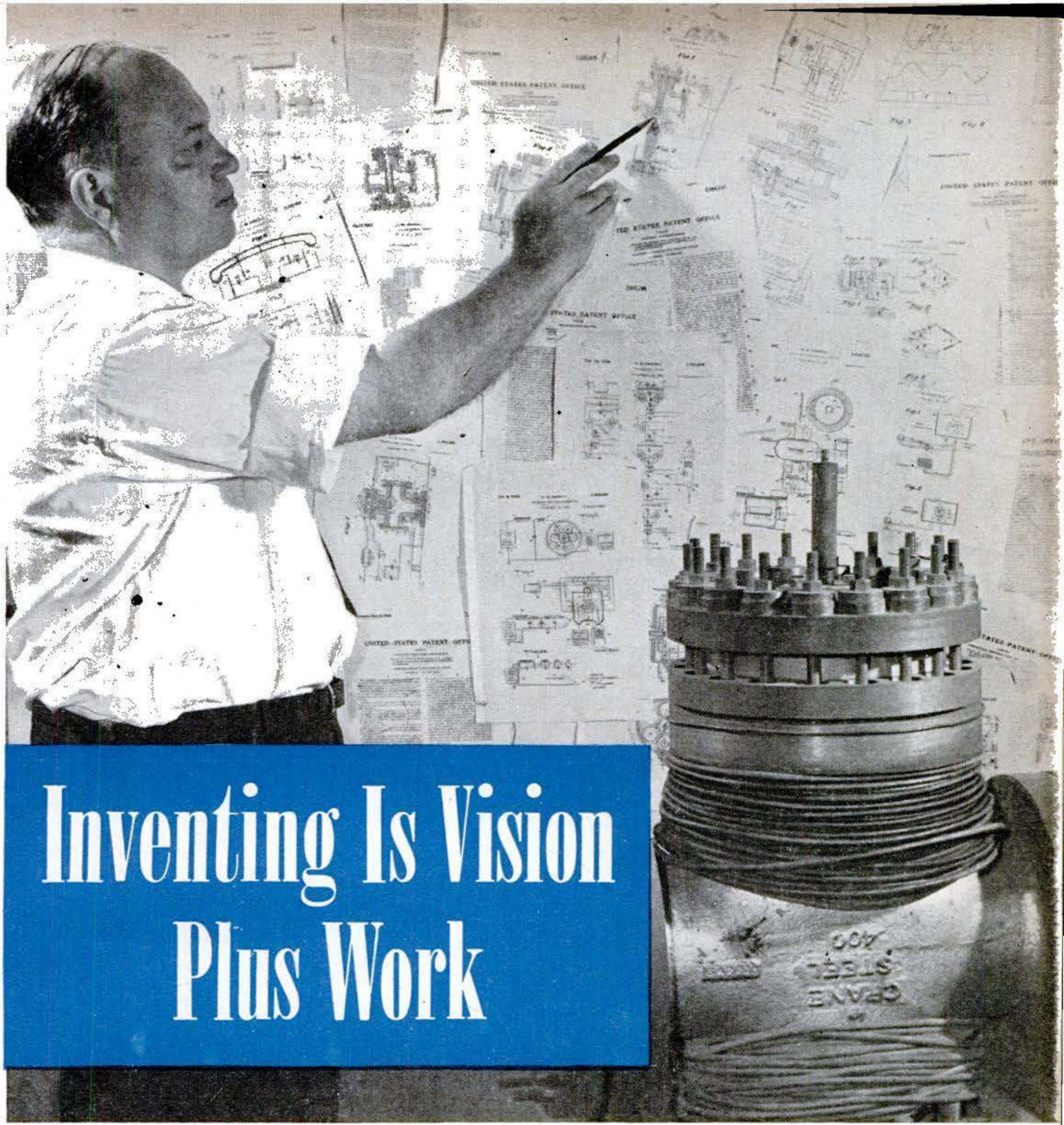

Inventing Is Vision Plus Work

Clarence W. Hansell examines a layout of some of his more important patents. In foreground is mysterious new vacuum tube that may someday be superpowerful industrial circuit breaker.

Clarence Hansell, the holder of 242 patents, saw what radio needed and produced it repeatedly.

By William P. Vogel, Jr.
PSM photos by W. W. Morris

ALMOST any intelligent person could have invented the phonograph, yet it took an Edison *to recognize the need* and *to make his idea a reality* by hard work."

Those are the two basic steps—recognition and hard work—toward successful invention, according to Clarence W. Hansell, most prolific inventor on the staff of Radio Corporation of America. Ranking fourth among U. S. inventors best known for their work in the electronics field,* Hansell in the last two decades has come up with 470 docketed inventions and received U. S. patents on 242 of them. More than 60 of these inventions have been important commercial developments in radio. They have helped to swell the coffers of RCA, whose trans-

*Electronics' top four, according to U. S. Patent Office: Edison, 1,101 patents; John Hays Hammond Jr., 396; E. F. W. Alexanderson, 314; Clarence W. Hansell, 242.

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mitter research laboratory at Rocky Point, L. I., Hansell has headed since 1925.

Hansell obviously does not believe in the "flash of genius" theory of invention. You may recognize a need while shaving or daydreaming in a hammock, he says, but you won't get a patent until you have worked out your idea the hard way and until you have determined just how your idea differs from perhaps hundreds of similar ideas for which patents have already been sought.

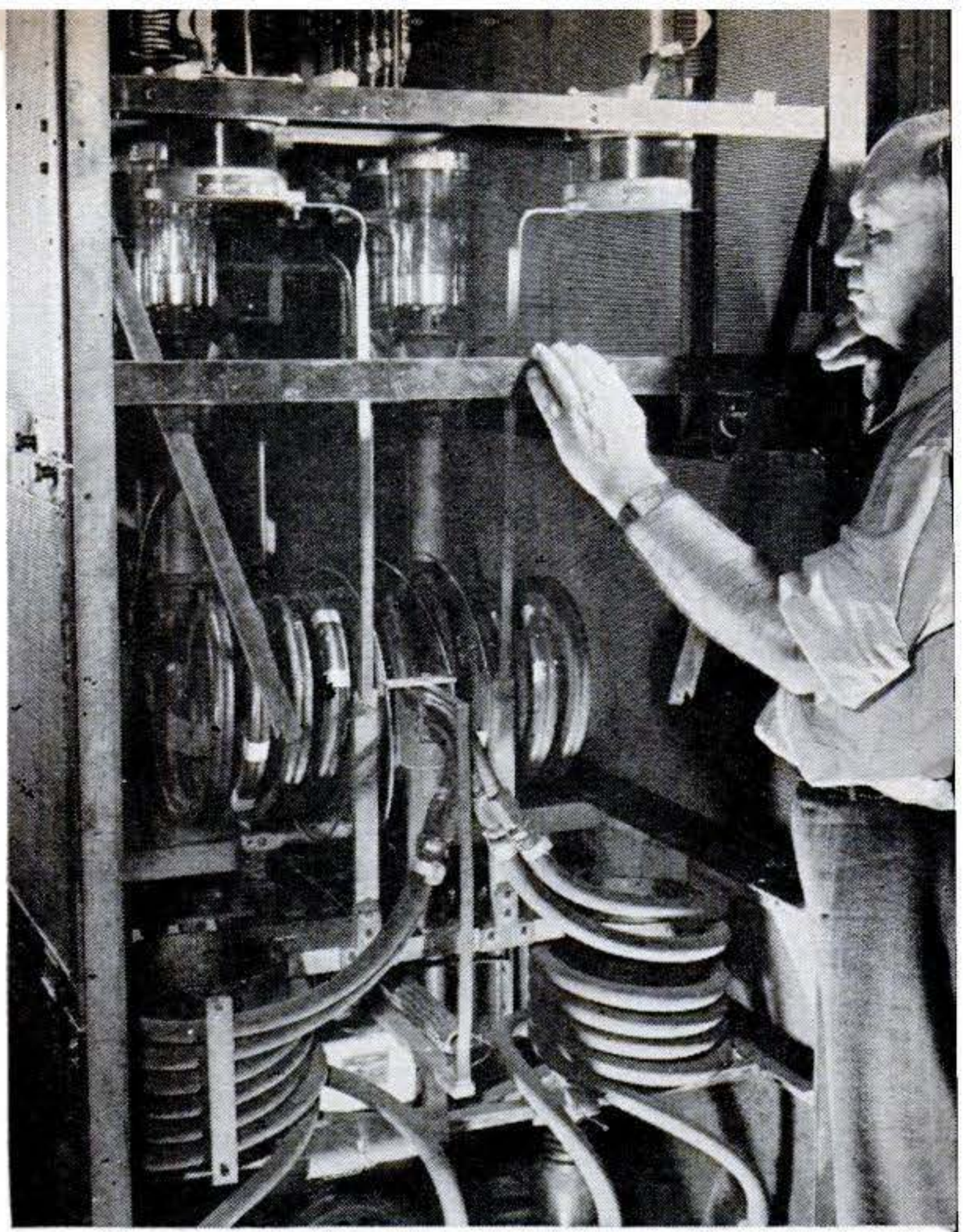
"It is surprising how blind people can be to needs, and then, once they recognize them, how hard it is to work out the details. Mankind has always had to lug things, but it took thousands of years to dream up such a simple device as the wheelbarrow."

Frontiersman of Radio

Hansell is a stocky, matter-of-fact man with thinning hair, not quite 50 years old. He is one of the little band of researchers who have steadily labored to push back the frontiers of the radio spectrum. He abandoned kilocycles for megacycles long ago and his inventions have completely changed the map of the ether and revolutionized RCA's struggling communications business. His inventive thumbprint is all over the huge center that RCA maintains at Rocky Point, where an arena full of automatic transmitters, attended by only five technicians, can pour out 6,000 words a minute, 24 hours a day.

Hansell's laboratory near the station does not in the least resemble the popular conception of a research center. It is an unmarked white metal building, studded with a few test aerials—and completely cluttered inside with machine tools, vacuum pumps and transmitters in various stages of construction. Administratively a part of RCA's laboratory division, Hansell and his team of specialists have virtually no outside direction. They never have formal meetings, but discuss their projects over lunch in Port Jefferson, where Hansell lives, or around a gadget in the lab shop.

The lab is Hansell's creation. In 1919, fresh from Purdue University in his native Indiana, he enrolled for the internationally famous General Electric test-training course at Schenectady. In the autumn of that year RCA was formed to develop America's radio industry. Hansell was one of the group of young radio enthusiasts who joined RCA at the outset. His first job was to test and install at Rocky Point and elsewhere the big high-frequency alternator equipment that had been invented by Dr. E. F. W. Alexanderson.



Hansell with his great achievement in long-range transmission: the output stage of a short-wave vacuum-tube amplifier. Copper pipes of transformer (bottom) carry water to cool tubes.

These alternators were the last of the great rotating machines that preceded vacuum tubes in radio transmitters. They were bulky, cumbersome and expensive. There was an even greater drawback: Their ultra-long waves—around 16,000 meters—could be used only at certain night hours.

Hansell recognized a need—and lost no time in trying to replace the big rotating equipment. By 1922 he and Dr. W. R. G. Baker, now a GE vice-president, had developed a long-wave vacuum tube transmitter for the Rocky Point station, but it was not commercially practical. Hansell then realized that long waves were never going to free transoceanic work from the interference of sunspots, magnetic storms and static. The theory of vacuum tubes was just beginning to be understood. With tubes, he realized, he could in time produce shorter waves. Why not try them for long-distance communication?

But when it came, the vacuum-tube transmitter was in a sense a by-product. "What we really started looking for," Hansell explains, "was a short-wave transmitter that

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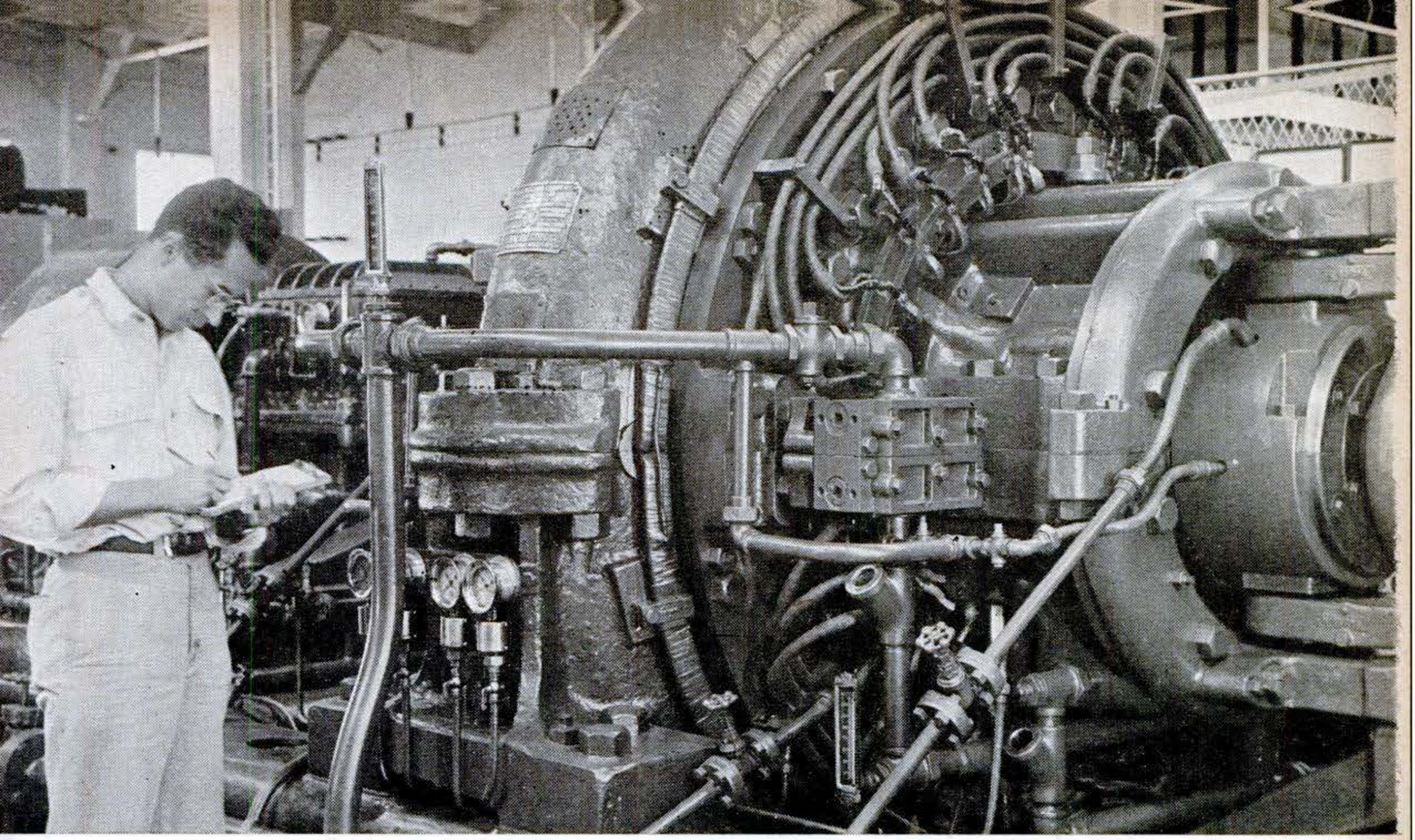

This Alexanderson alternator does same job as one of the tubes on opposite page. Supplanted by Hansell's vacuum-tube transmitter, it is still on stand-by service for RCA and is used when magnetic conditions blank out short waves. During the war the Navy used it to signal submarines under water, where short waves do not penetrate. It does not work at night.

the telephone company could use. But the inventor's course is a tricky one. He should be allowed to follow it naturally. We were, and we came up with something more important for communications and for commercial use than our original objective."

Three years of intensive experimenting were devoted to the tube and the shorter waves that it made possible. The primitive vacuum tubes of the prebroadcast days were delicate and cranky. They often failed because of structural defects and overheating. In addition, the shorter waves that they were to produce were highly suspicious characters. Some learned men of radio had solemnly pronounced that nothing shorter than 200 meters would ever be of much use, and an indulgent government had given radio hams the right to fool around in that spectral region. Hansell and his team of researchers discussed and measured, lashed up rigs and tore them down.

In 1925 came success. Hansell and George L. Usselman developed a vacuum-tube circuit to transmit at 15 meters, a wave length far shorter than even those Marconi had been toying with. To control frequency they used the new-fangled piezoelectric quartz crystals; the 20-foot aerial was tied with clothesline to two poles 70 feet high. Everything, including development, cost about $15,000. With this rig, using seven kilowatts of power, they handled very nearly all the commercial traffic from Europe and the United States to South America. What was more, they transmitted during daylight, peak performance coming about noon. The million-and-a-half-dollar Alexanderson alternators, delivering 200 kilowatts to antennas 1½ miles long and 410 feet high, were soon on stand-by service.

But there were more bugs to be worked out. "That first transmitter did the job where the alternators failed," Hansell recalls, "but it was a tricky circuit. We were greatly troubled by feedback from plate to grid circuits within the tubes and from other circuit components from one stage to another. We built the best shields we could, but you could light a 100-watt lamp by bringing it into the electromagnetic field surrounding the amplifier. We used to sit around and talk about multiplying frequency in successive stages, and finally an old lab mechanic horned in. 'Well, he said, 'if that might do the trick, why in hell don't you stop talking and start building something?' "

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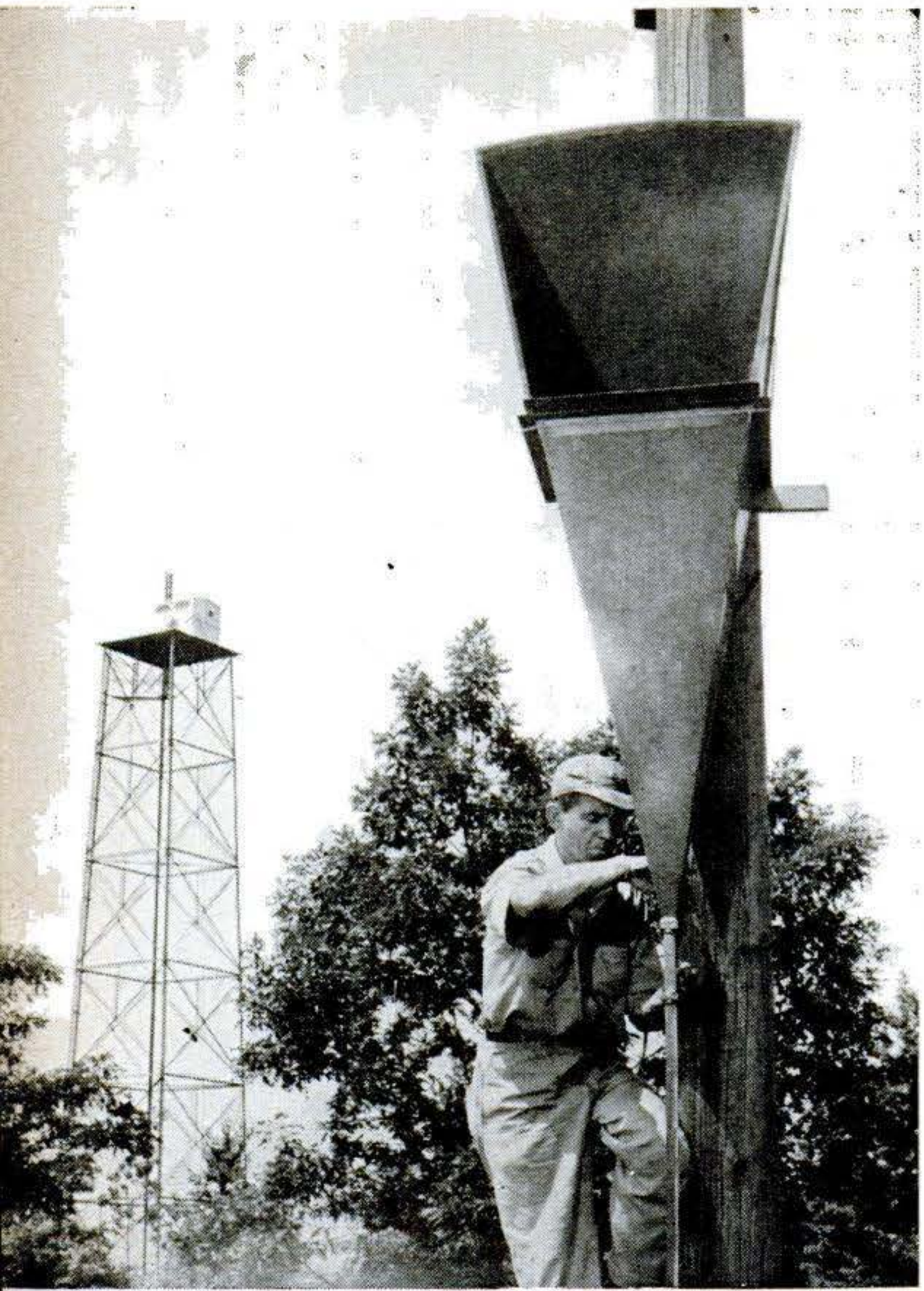
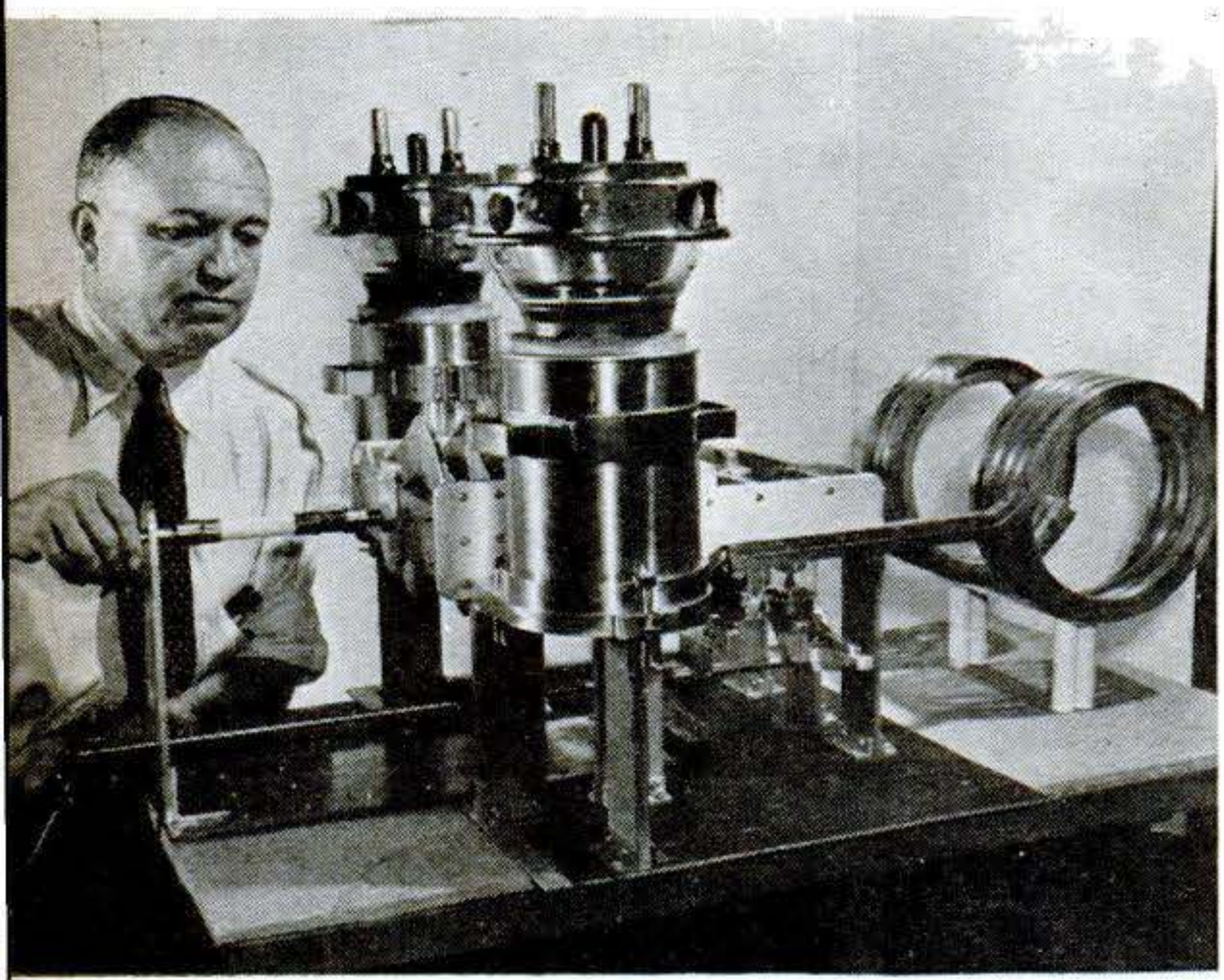


Scale model of highly directional Hansell transmitting antenna. Horn makes wave-front of signal impulse flat, instead of spherical as in parabolic type on tower, and does not discriminate against different frequency bands.



Latest model of Hansell's experimental transmitter output stage, using 9C27 power triodes, has hot water circulating through shields around anodes. Hot water cools better than cold!

Hansell did build something—a better transmitter in which the frequency was multiplied in successive stages of the amplifier instead of in one stage at the beginning of the circuit. The result was a big gain in stability, and the new design at once became standard all over the world. Indeed, Hansell's 1926 transmitter is still on active duty at Rocky Point.

Since then, Hansell's inventions have covered almost every aspect of radio communications. To improve transmitters, he developed an elaborate theory of temperature-distribution control. He found that the mysterious internal **flashover** (known throughout the world as the "Rocky Point effect") that sharply limits tube power could be minimized by keeping certain inside surfaces warmer than others. Thus he developed a method of indirect water cooling for tubes that promises great commercial value. Another problem on which he has been working for years has been the improvement of aerials to obtain greater directivity and lower line losses.

Workable Invention Not Enough

Not all inventions prove to be worth the candle. Hansell once developed a high-speed ink-jet recorder that would transcribe the dots and dashes of radiotelegraphy on moving tape. "We were needled into the job," he says, "by communications people who wanted to record faster than the 60 words a minute an operator could handle. We made a glass capillary, forced ink into it at 150 pounds' pressure, and moved the fine jet electromagnetically. With it we could take words down at 7,500 per minute, but the tape had to move at 20 m.p.h.

"One day the head of the communications traffic department came out to Rocky Point. We unveiled the new jet for him. He sat and looked at it. Then he said: 'It will never be any damned good.' He saw his traffic department cluttered up with miles and miles of paper tape, messages delayed or lost, everything in confusion. So he ended up by ordering a lot more 60-word-a-minute circuits."

One of the most obstinate problems Hansell has ever worked on is radio relaying. Although there has been much talk of tying television networks together with coaxial cable, and many miles of it have been laid, Hansell is convinced that relays will be the long lines of the future. He points out that the theory of coaxials has been much fur-

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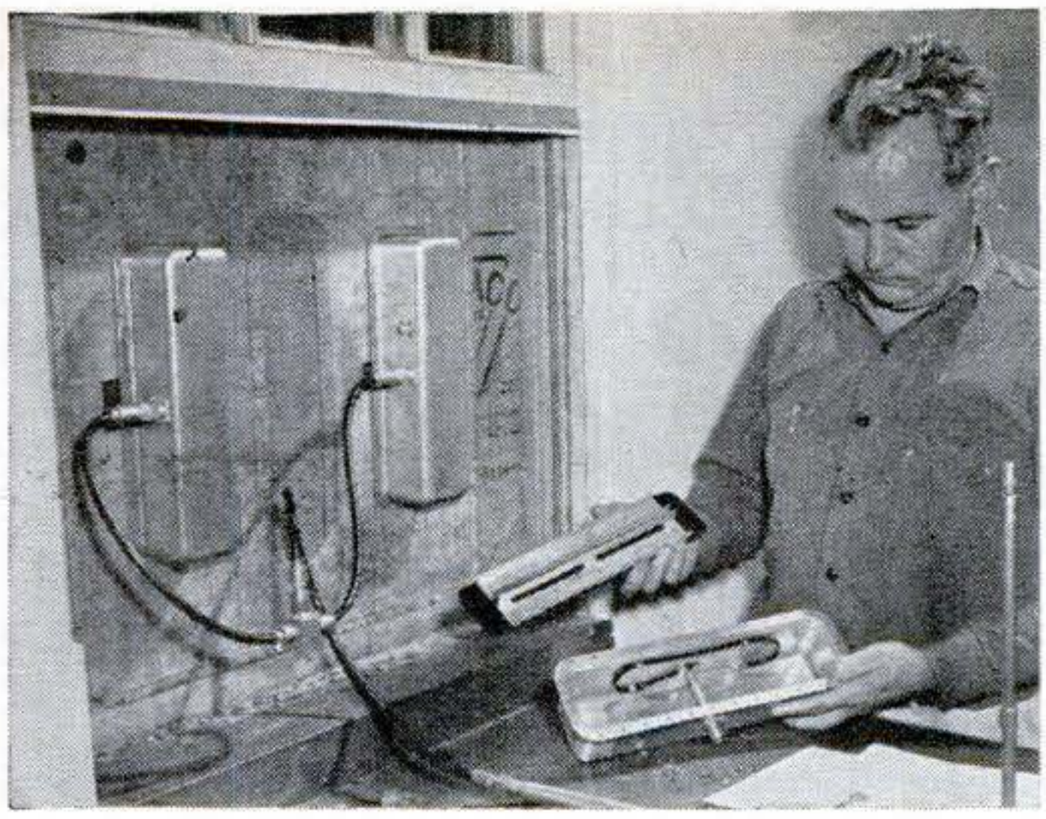
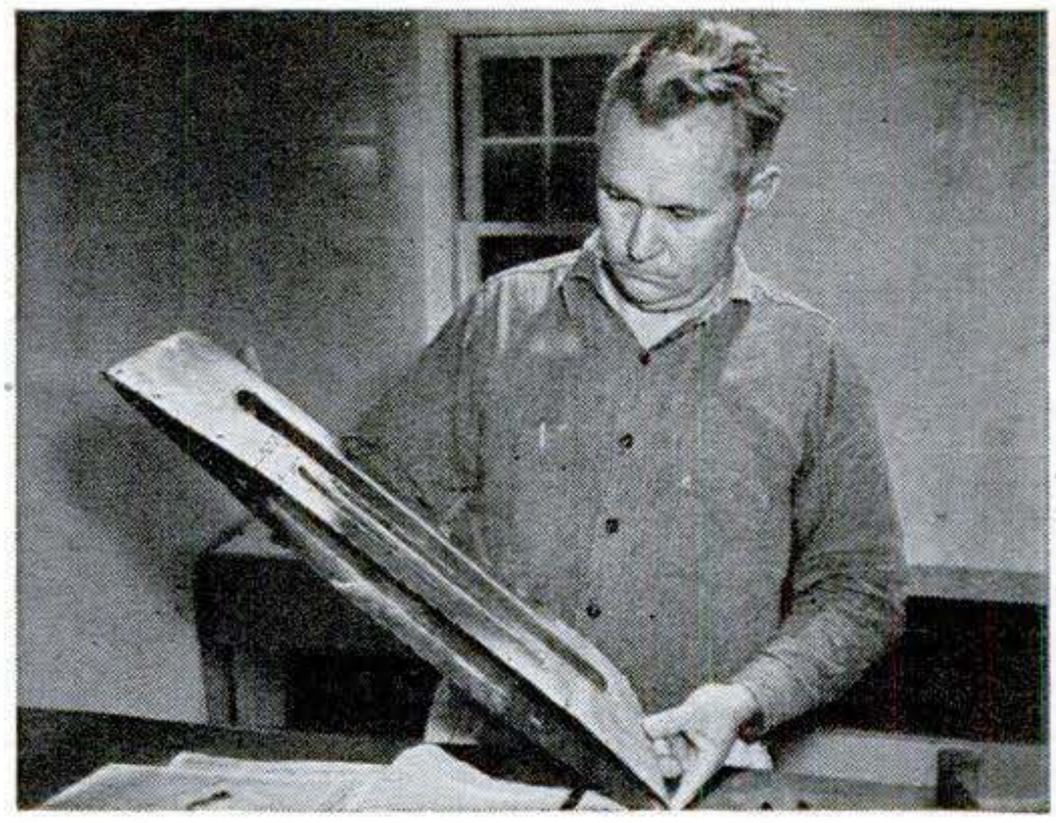


"Zero-drag" antenna for high-speed aircraft altimeters is flush-mounted under wing or fuselage. Left, radiating surface; right, coaxial cavity that directs wave impulse to antenna.



This buckle-slot antenna is a zero-drag type for use on wing or stabilizer tips. Aim is to get 360° propagation pattern. Antennas are a research project in Hansell's laboratory.

ther developed than the theory of relays. "There are still things to be done," Hansell says. "The tubes for good relaying are just beginning to be available and it will take some time to build circuits around them."

Following his own rule that research should never be circumscribed, Hansell never tries to limit his interests. He got to brooding several years ago about the magnetron tube that gives radar its short, immensely powerful bursts of short-wave energy. The total current passed by the tube was far greater than could be accounted for by the thermionic electrons released from the hot cathode. Obviously many secondary electrons were knocked out of the cathode by high-speed thermionic electrons whirling in the tube and eventually returning to the cathode. Now he has patented special electronic arrangements that may revolutionize production of high-frequency power. About his invention, Hansell wrote:

"Here is a demonstration of a new principle with which it is possible to substitute control of cathode emission for grid control in vacuum tubes, and it seems entirely possible that exploitation of the principle will render most existing types of transmitting tubes obsolete."

Lone Wolf Inventor Out of Date

Besides inventing, running his laboratory and keeping in touch with a thousand different developments in electronics, Hansell also gives a lot of thought to the role of the inventor in present-day society.

"The picture is no longer that of a man struggling in a garret to gain recognition," he says. "Rather the inventor is one of a nameless, cloistered group employed by a big company that may or may not understand the real aim of research."

Hansell believes that no one should ever try to dictate the course of research. The recognition of need must come from the inventor himself, not from the sales manager—"for if the sales manager asks for something to sell," Hansell says, "chances are it's far too late. Your competition will already be ahead of you."

Among his chores for the future Hansell gives several priority. Even in high-frequency work the spectrum is crowded; the only answer is to go higher and to develop multiplexing and relaying. The problem of "ghosts" in television is far from solved; an exhaustive study of multipath reception is indicated. Vacuum tubes can be made more effective and circuits more stable if more is learned about their operation under various temperatures. That alone could take up a lot of his lab's time.

Hansell's first mentor, Dr. Alexanderson, once wrote: "Scientists do not have any turning points in their lives. They go straight ahead and one thing leads to the next. The inventions of tomorrow can be forecast if we know how to interpret what is going on today."

It would seem that Hansell is doing quite a job of interpreting. END

A Sunny Day Rivals a Coal Mine

THE sunlight falling on one square mile of farmland on a sunny day gives as much energy as could be released by burning 6,000 tons of coal in a furnace.

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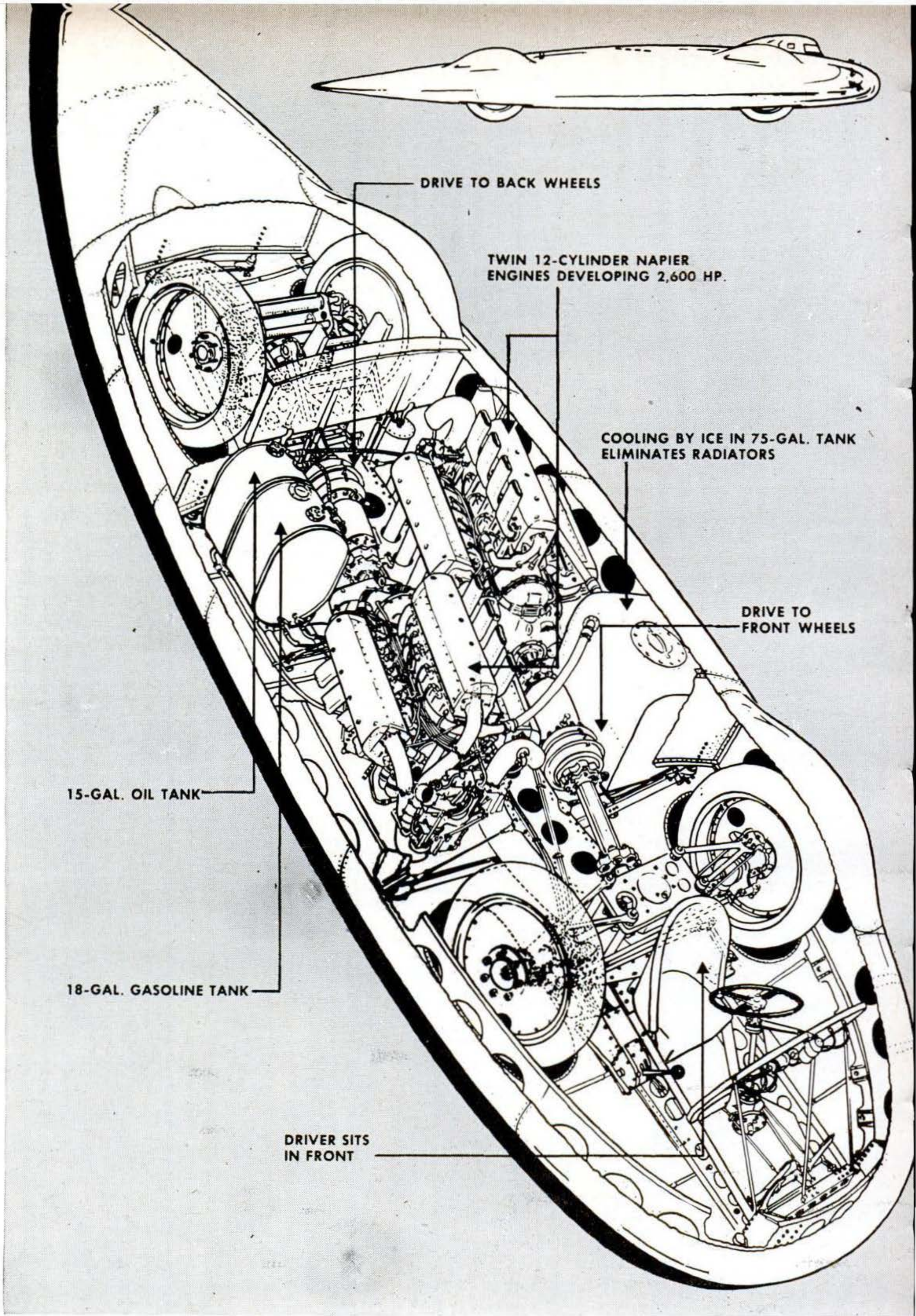

Cutaway shows car's complex original design. The fuel and water tanks were later reversed.

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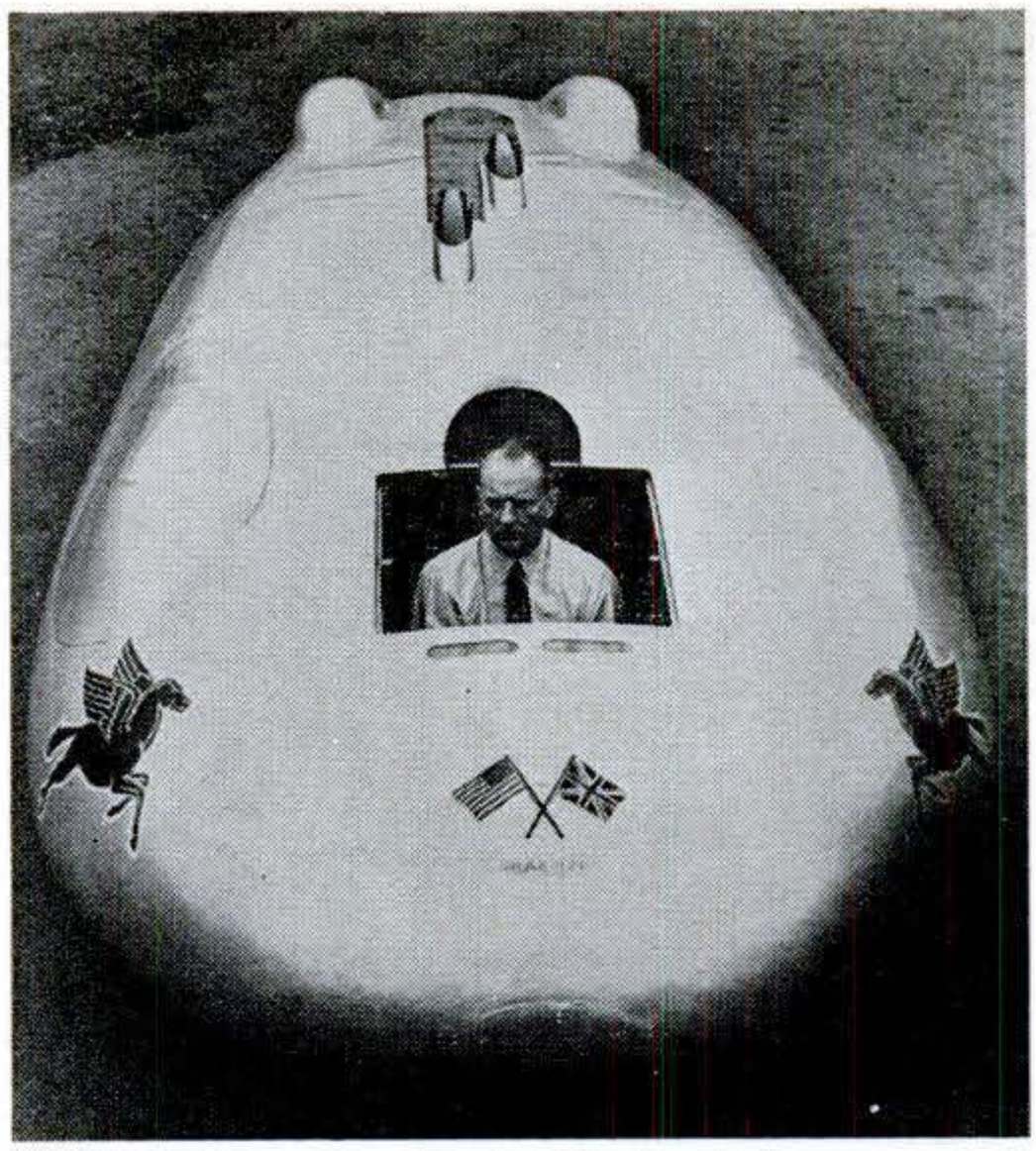
Fastest Auto In World Races Against Itself

FOR his first post-war assault on the world's land speed record, John Cobb of Britain chose the same car and the same course that he used to set the existing mark —369.7 m.p.h.—in 1939. The car was his 2,600-hp., twin-engine Railton Special; the course, Utah's Bonneville Salt Flats.

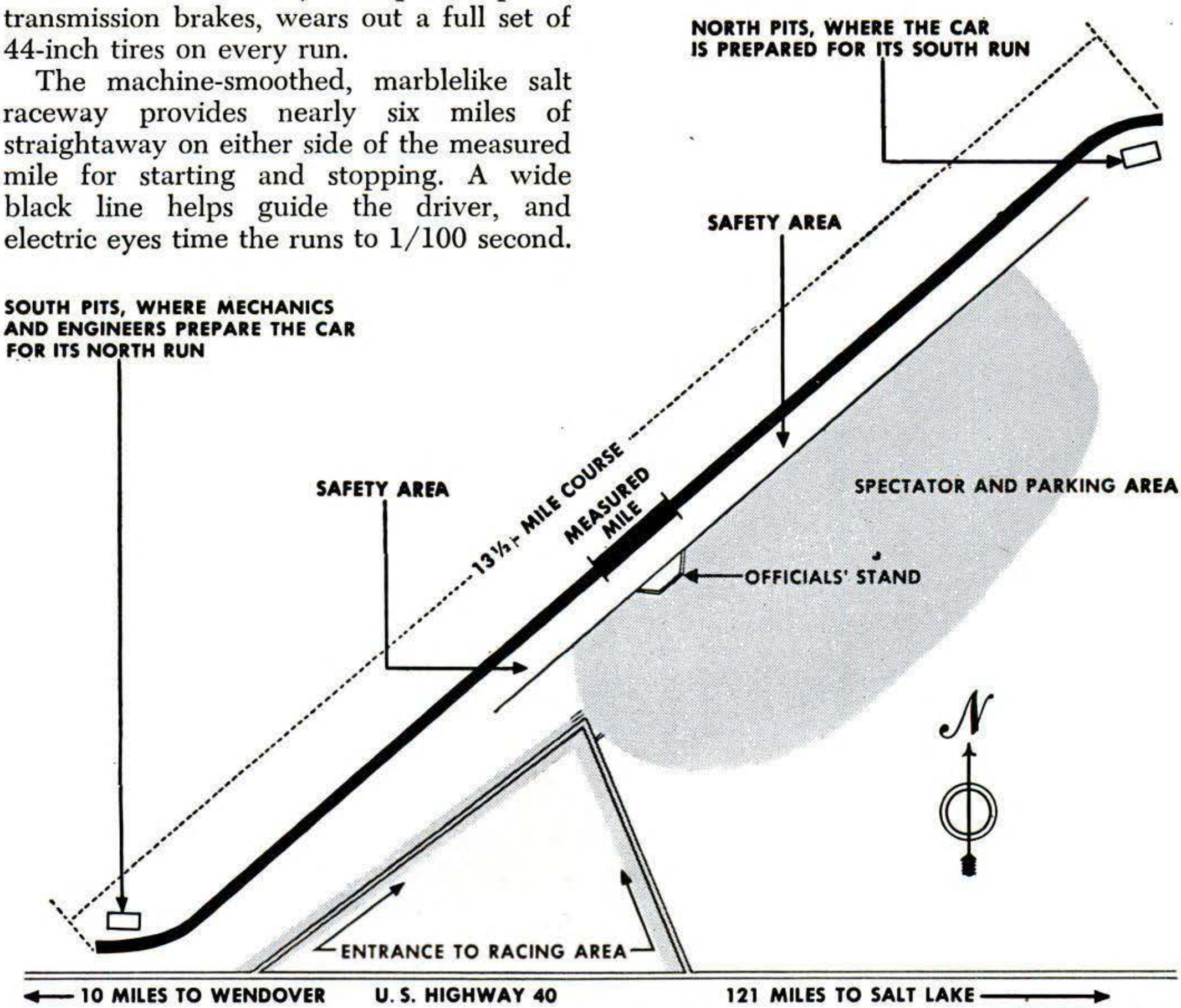
Cobb's reconditioned $100,000 racer (PSM, Sept. '47, p. 81) features a unique four-wheel drive in which the rear engine drives the front wheels and the front one the rear wheels. A 400-pound, removable aluminum-alloy shell completely streamlines the car.

Started by pushing, the three-speed, reverseless machine shifts into second at 140 m.p.h., into high at 240 m.p.h. Weighing in at close to four tons, it requires special transmission brakes, wears out a full set of 44-inch tires on every run.

The machine-smoothed, marblelike salt raceway provides nearly six miles of straightaway on either side of the measured mile for starting and stopping. A wide black line helps guide the driver, and electric eyes time the runs to 1/100 second.



Wide and squat, the beetle-backed racer poses with Cobb at the wheel. Cockpit, uncovered above, is well forward for maximum visibility.



The established course provides about 13 miles of straightaway, but Cobb would like more.

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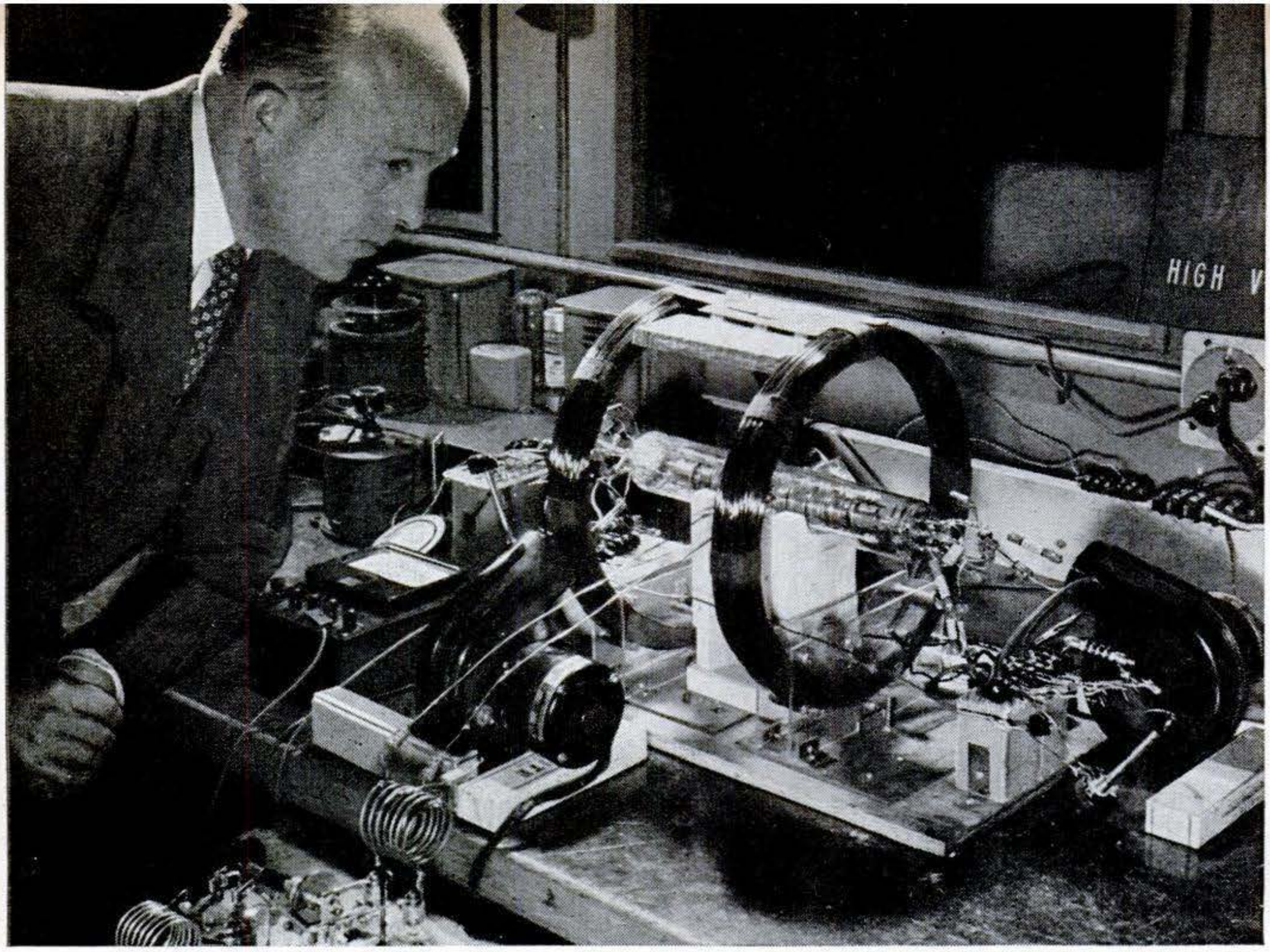

With table-top model, Dr. Skellett demonstrates new way to generate ultrahigh voltage.

Atom Gun—New Style

Palletron, a vacuum tube with a novel principle, promises a simpler method of generating artificial lightning.

A VACUUM tube named the palletron promises to become a new tool to smash atoms and produce superpenetrating X-rays for medicine and industry. According to its inventor, Dr. A. M. Skellett, of the National Union Radio Corporation, Orange, N. J., successful tests of a foot-long model show how to build larger "atom guns" generating direct current of 1,000,000 volts and more.

Extremely high voltages delivered by existing artificial-lightning machines last only a split second. For a steady source of high-voltage direct current, the Massachusetts Institute of Technology's 10,000,000-volt Van de Graaff generator, housed in a hangar and using whirling motor-driven belts of silk to pile up charges on 15-foot aluminum spheres, has set the style.

In contrast, Dr. Skellett envisions an upright dumbbell-shaped tube, compact and inexpensive, with no moving parts. A 1,000,000-volt model would stand 12 feet high. Its 10,000-volt high-frequency supply unit would plug into any electric outlet. Power enough to hurl a blinding arc across a 10-foot gap would run an X-ray or ion tube connected to the generator. Any college or commercial laboratory could afford the estimated $25,000 cost of this model. Larger tubes would yield higher voltages, which increase much more rapidly than in direct proportion to size. With terminals in a vacuum, no leakage of electricity into air would limit the maximum voltage attainable.

To understand the palletron's principle, Dr. Skellett suggests, you could liken voltage to altitude. The higher a platform from which you dive, the harder and faster you will strike the water. And the higher the voltage to which you raise electrons, the faster and more forcibly they will strike a target, as in an X-ray tube.

You might ride up to a high diving platform in an elevator, and a Van de Graaff generator might be compared to an elevator hoisting electrons to a high-voltage level. There's another way to reach the platform.

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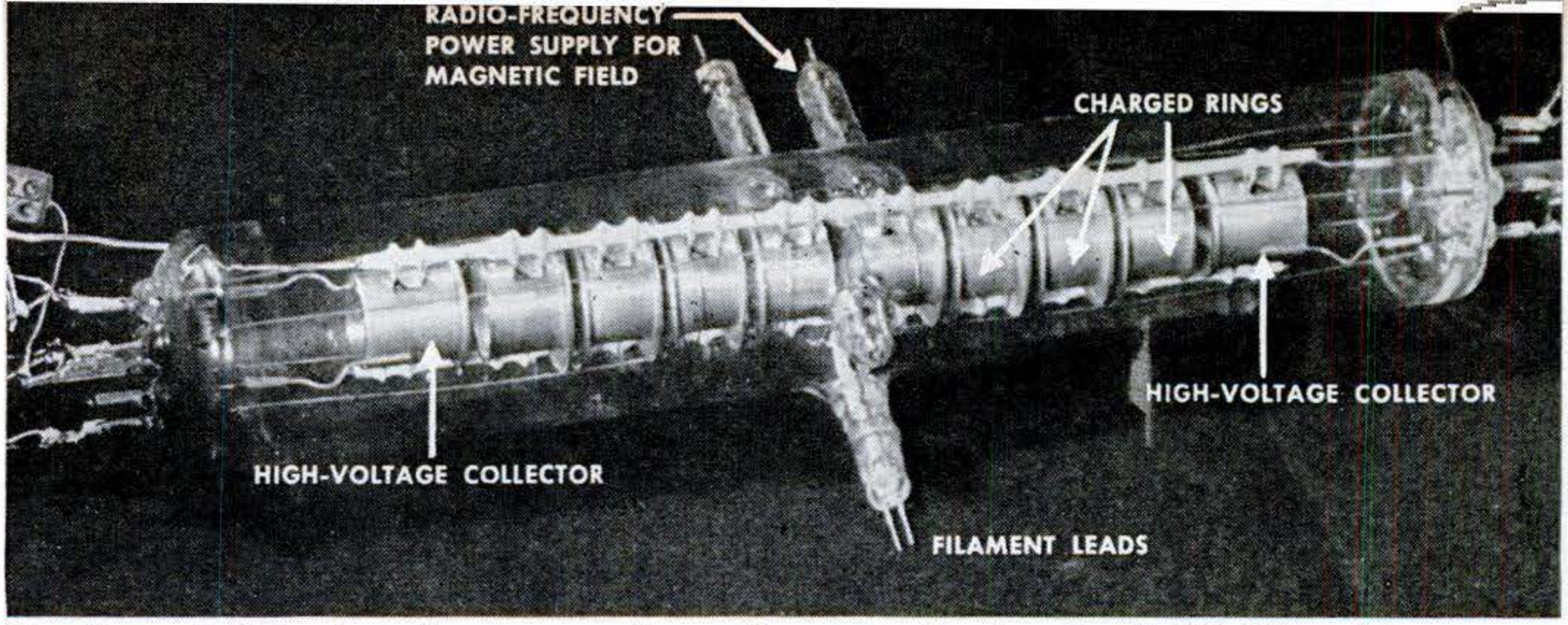


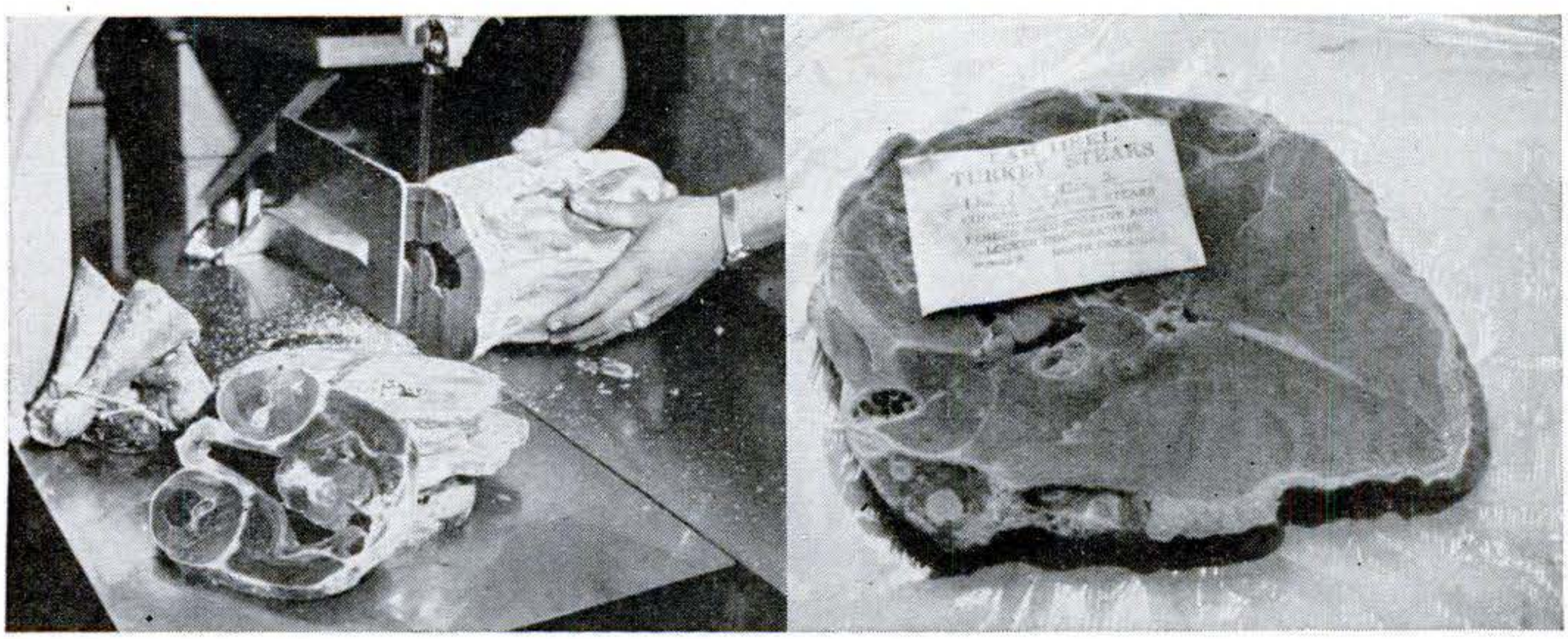
Foot-long, 1,250-volt palletron may be predecessor of tubes for 1,000,000 volts or more.

Suppose you are given a gentle push as you sit in a swing, and that the push is repeated, in the direction you are moving, each time you pass the ground. Swinging higher and higher, you can finally step from swing to platform as easily as from an elevator.

Exactly the same thing happens to electrons in the palletron, which takes its name from a Greek word meaning "to vibrate." A magnetic field at the center of the tube gives a push to an electron released there, from a hot tungsten filament, and starts it swinging along the tube's central axis. Charged rings encircling its path gradually check it and start it back again, to get another boost each time it whizzes past the center, until it acquires enough energy to clear all the rings and alight on a collector plate at one end or the other. Both collectors, which may be interconnected, become charged to high voltage.

Fed with 50-volt, 30-megacycle alternating current, Dr. Skellett's test model produced 1,250 volts of direct current. The electrons, he figures, made the "uphill" trip from filament to collector in nine swings. Current flow reached 20 millionths of an ampere. A large palletron, he predicts, should deliver 1/1,000 of an ampere, or the sizable figure of one kilowatt of power, at 1,000,000 volts.

The versatile palletron might also be operated in reverse, by applying direct current to its collector plates, to generate high-frequency current for television and radar. And a modified type, deflecting the electron beam to an offset target at its mid-point, would serve directly as an X-ray tube. END



Turkey Comes in Steaks

ONE of these days your grocer may reach into his freezer and bring out a new delicacy: turkey steak. In the new packaging method, originated by two North Carolina turkey raisers, the birds are frozen solid and sliced with a band saw into sections resembling steaks, which are neatly wrapped and kept at −10° F. Slices contain both white and dark meat, and they are sold with ingredients for making gravy.

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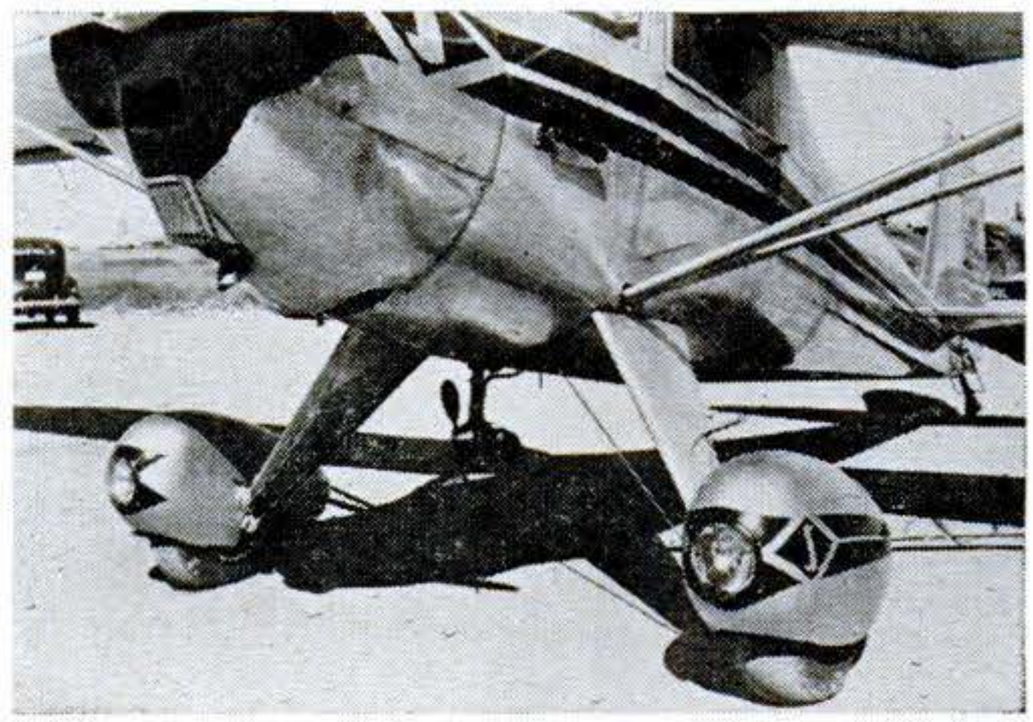
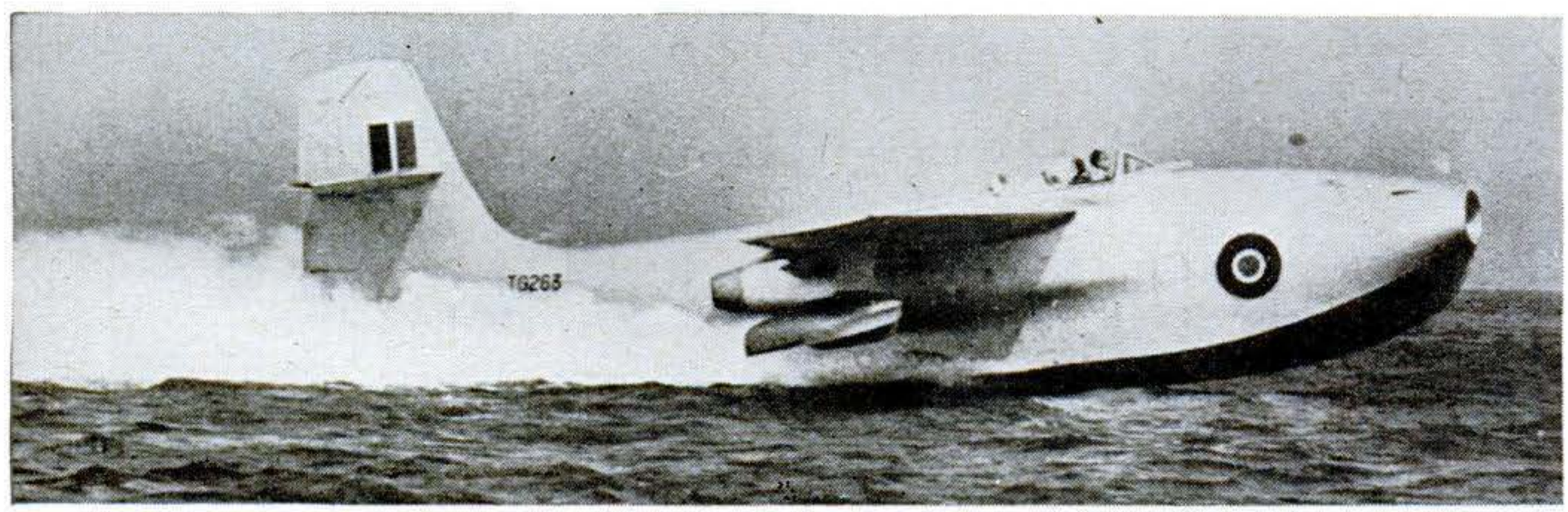
WHAT'S NEW IN AVIATION

Seahawk Hits the Waves. The Navy's new scout observation seaplane, the Curtiss SC-2, recently passed rough-water landing tests with flying colors, bucking five-foot waves and 35-mile winds. Main job of the 250-m.p.h. Seahawk is scouting from battleships, but it also will be used to spot gunfire and for search and rescue.

Ingenuity at Work. At San Diego Naval Air Station there's no more rolling out drums to catch drained engine oil. A 150-gallon droppable fuel tank, cradled in a bomb trailer, is towed under the plane by jeep. Arrow indicates drainpipe.



Plastic Protects Wheel Lights. Use of crystal-clear plexiglas lenses keeps these new lights from being broken by stones picked up by propwash on landings. Developed by Aviation Accessories, lights are for fixed or retractable landing gear.



Jets Propel Flying Boat. A world's first, Britain's twin-jet Saro SR/A1 is a single-seat fighter, high-winged to clear water. Both engines are inside hull with tailpipes on either side. A single large air intake in bow prevents shipping water.

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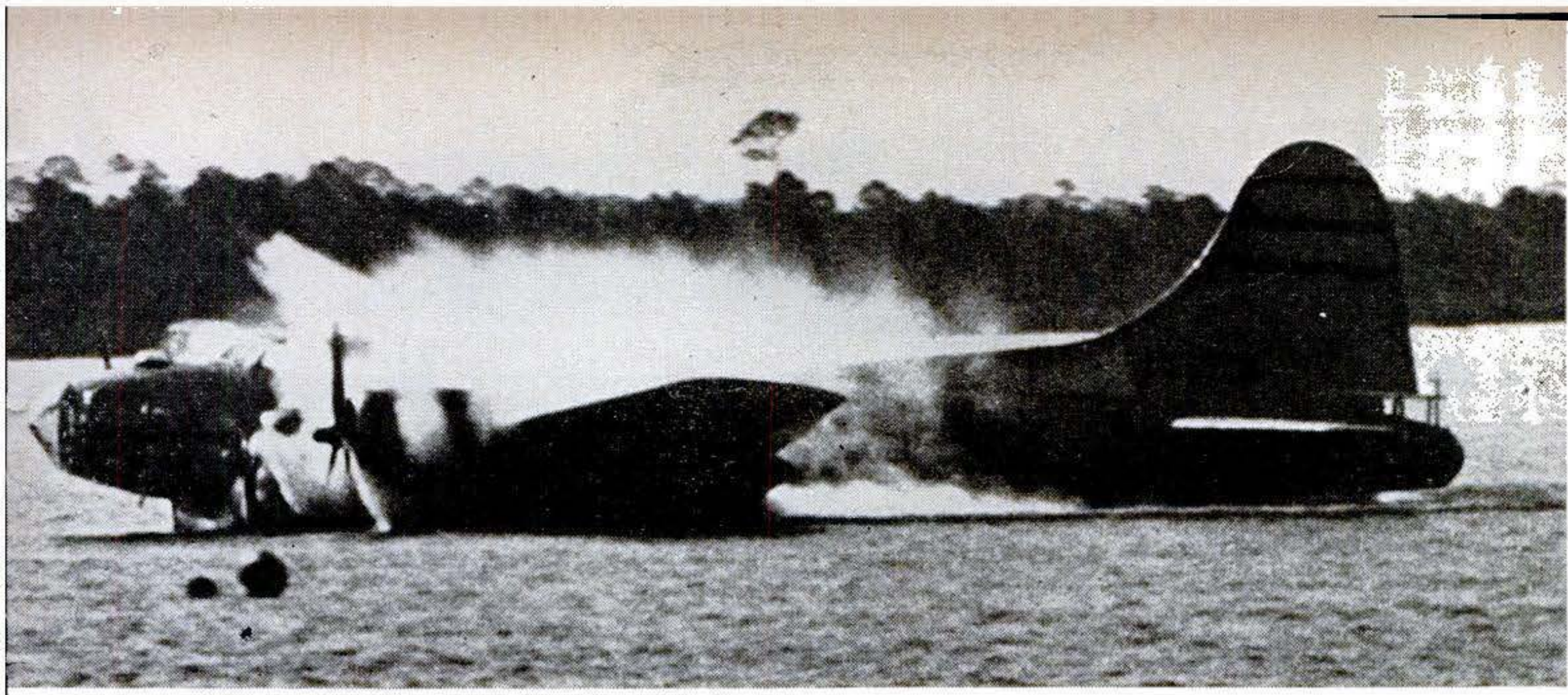
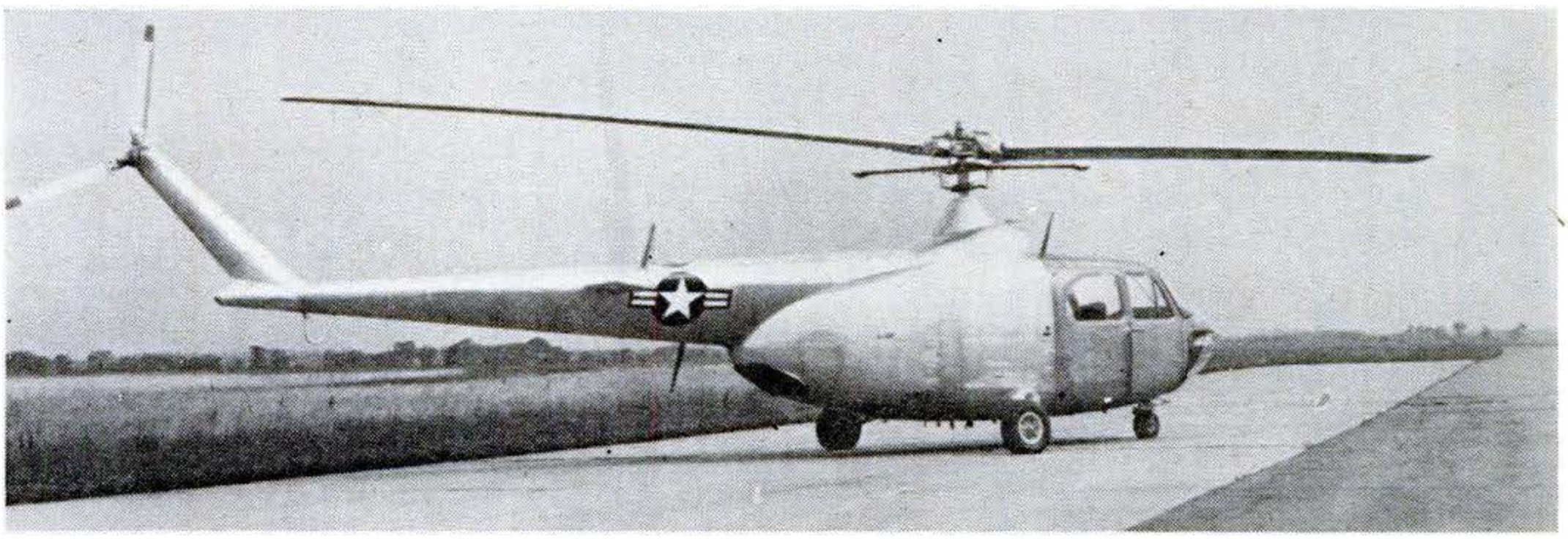


Ditching Tested. This crewless B-17 has just been radio-guided by a mother plane into a water crash-landing. Special instruments and eight movie cameras aboard the plane recorded the crash and damage. Resulting data will be used by the Air Forces to determine best ditching methods and to strengthen aircraft against impact.



Lots of Jobs Ahead. Personnel and cargo transport, observation, liaison and ground co-operation are among many missions planned for the new Bell XR-12 helicopter. Now under test for the Air Forces, the XR-12 has a Pratt & Whitney nine-cylinder, 550-hp. air-cooled engine. It climbs vertically at 450 feet per minute, has a 105-m.p.h. top speed and a 300-mile range. A conventional antitorque rotor is at the end of the tail boom. Total weight is 5,803 lb.; payload, 1,630 lb.

Silvaire Grows Up. New four-place version of Luscombe's two-place job of the same name, this all-metal utility plane features more cargo space, increased visibility, and lower operating cost. It has 165-hp. engine, 500-mile range, 130-m.p.h. speed.

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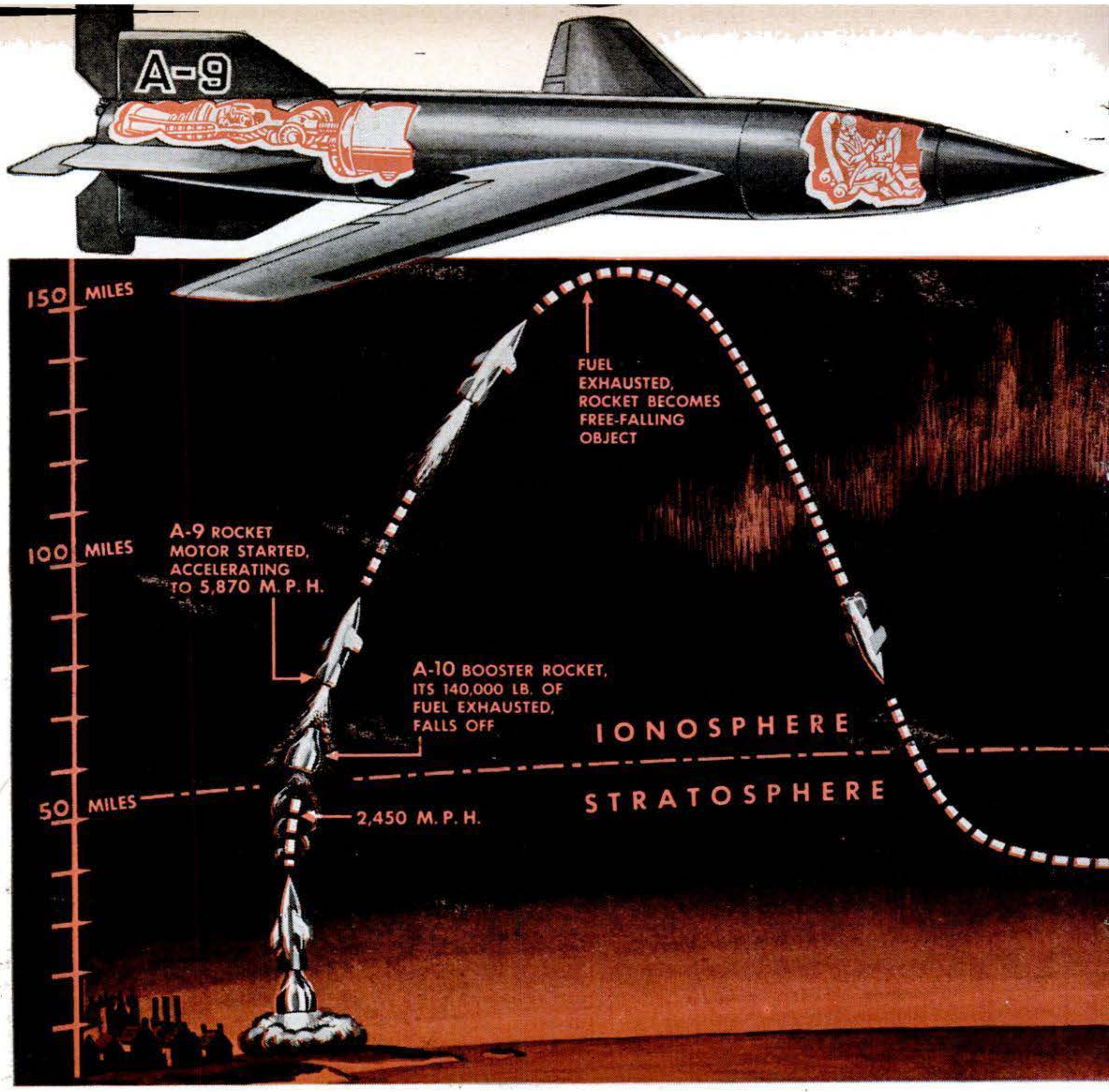

Target New York: Two-stage supersonic rocket was goal of Nazis' A series of secret weapons.

Transatlantic Roller Coaster

WHEN the Allied invasion upset the Nazis' plans, they had a supersonic, 3,000-mile-range rocket in the works. Already in the blueprint stage was its successor —a true rocket bomber of equal speed and range. Actual sketches and plans for it are shown on page 110.

Rocket projects were Hitler's equivalent of America's Manhattan District Project. Blueprints for atomic bombs are still tightly guarded secrets, but the Nazis' detailed plans for push-button, transoceanic war have now been exposed. They are a clue to developments that may reasonably be expected if there is another war.

If the invasion of Europe had been delayed six months, German robot missiles and piloted rocket bombers would have been hurtling across the Atlantic. Rocket bombing of New York was scheduled for early 1946.

In 1943 Germany's top scientists were

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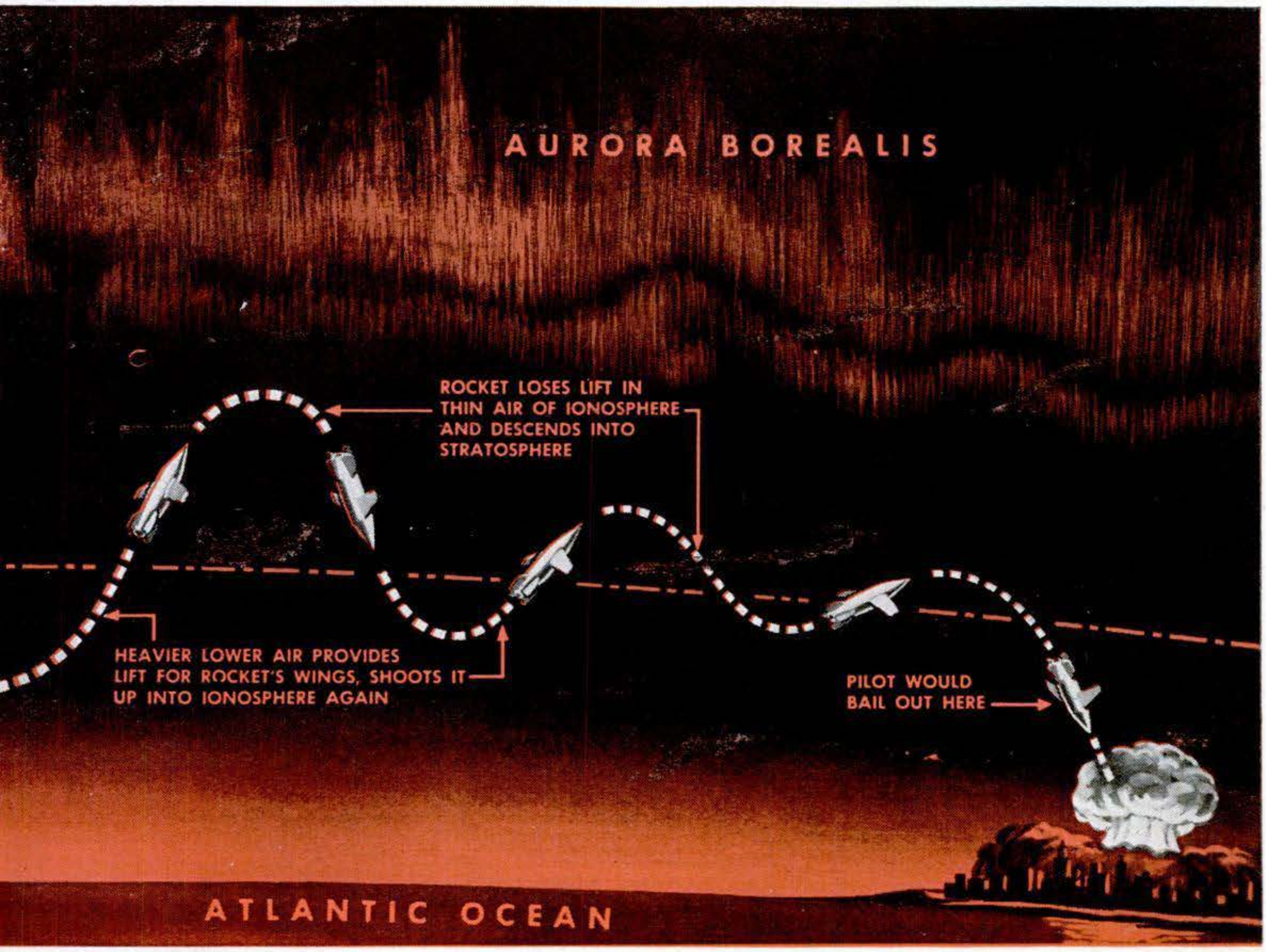
Hitler's blueprints found; mighty winged missiles were to be used in 1946.



Rocket bomber, planned as next step, was to follow this path, drop bombs, and then land.

Designed to Bomb U.S.A.

drafted for work on the A series of guided and piloted rockets. The first three of these rockets were designed for basic research in aerodynamics, airframes and propulsion. The first "commercial" model was the A-4, better known to us as the V-2, which made its devastating debut on British soil on September 8, 1944.

The A-4 was a product of the A series far enough advanced to market death while Hitler's scientists developed deadlier and more far-reaching missiles. Next came the A-5, which was only one-half the size of the A-4. It was used for experiments in new control mechanisms. This was followed by the A-6, designed for tests at supersonic speeds.

But range was what the Nazis wanted—range to reach the United States. And wings would have given it to them. Wings would permit a rocket, after achieving maximum speed and altitude, to skim and skip between

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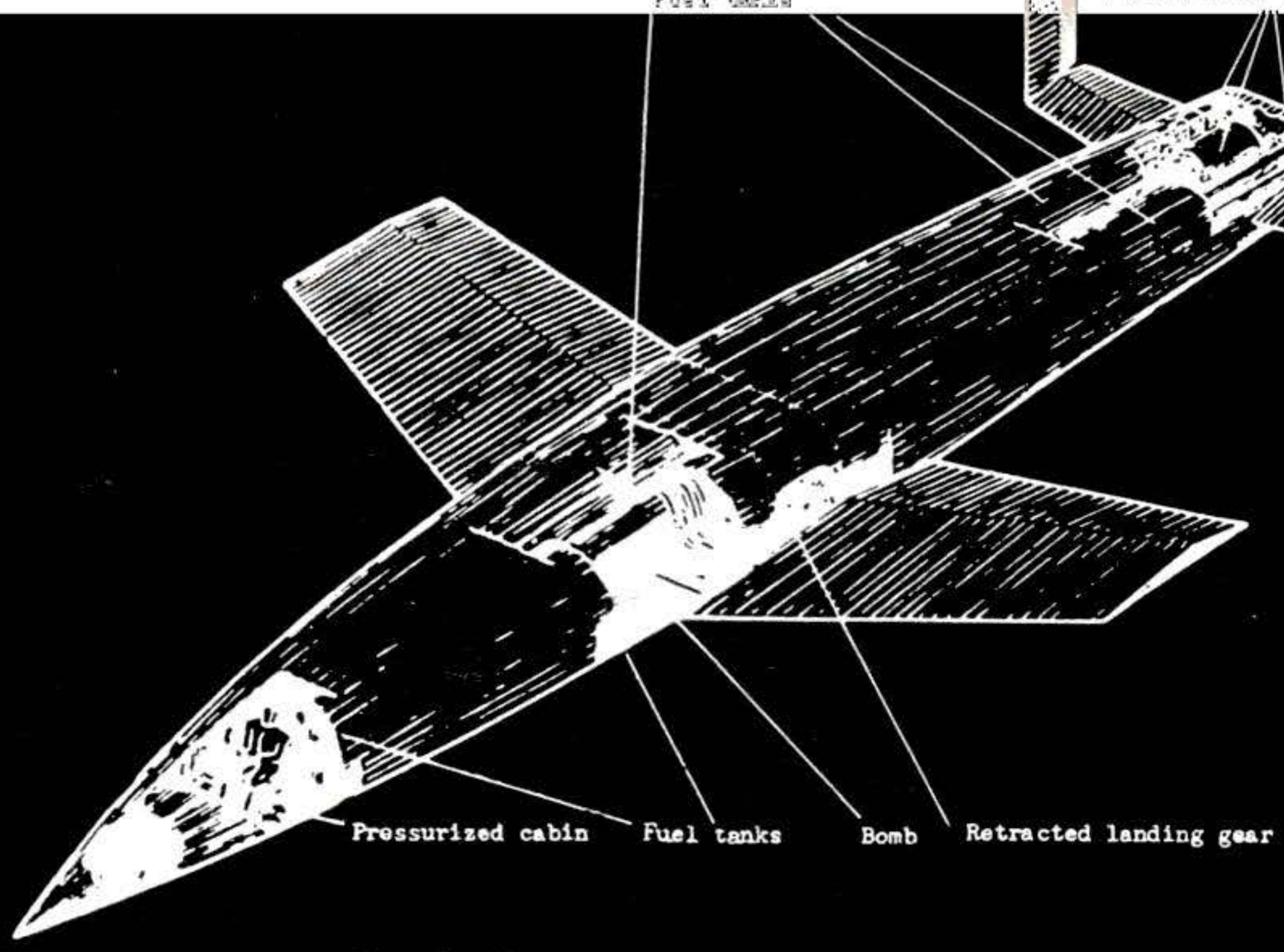

Fig. 58 - Sketch of German Long-Range Rocket Bomber

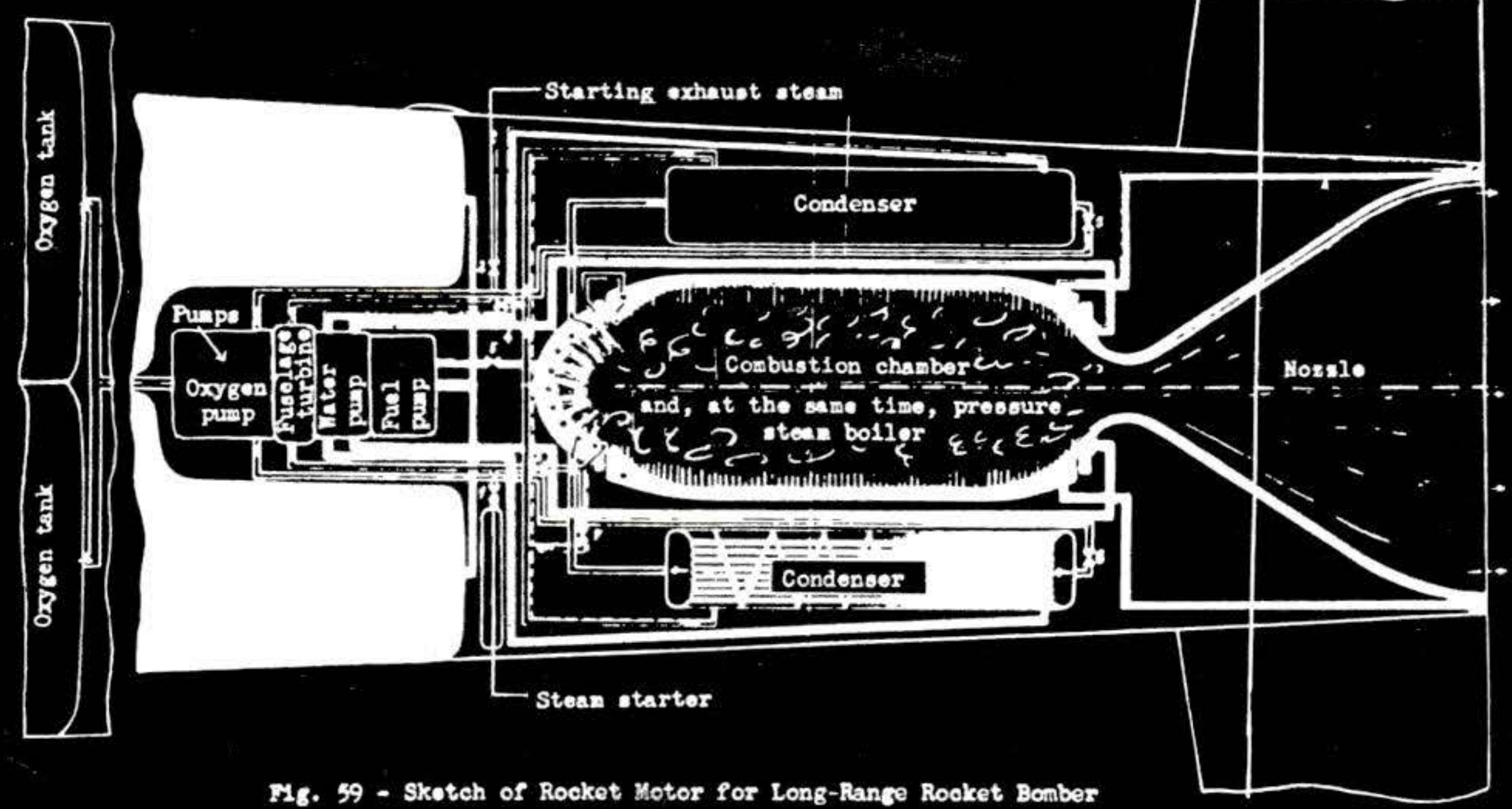

Fig. 59 - Sketch of Rocket Motor for Long-Range Rocket Bomber

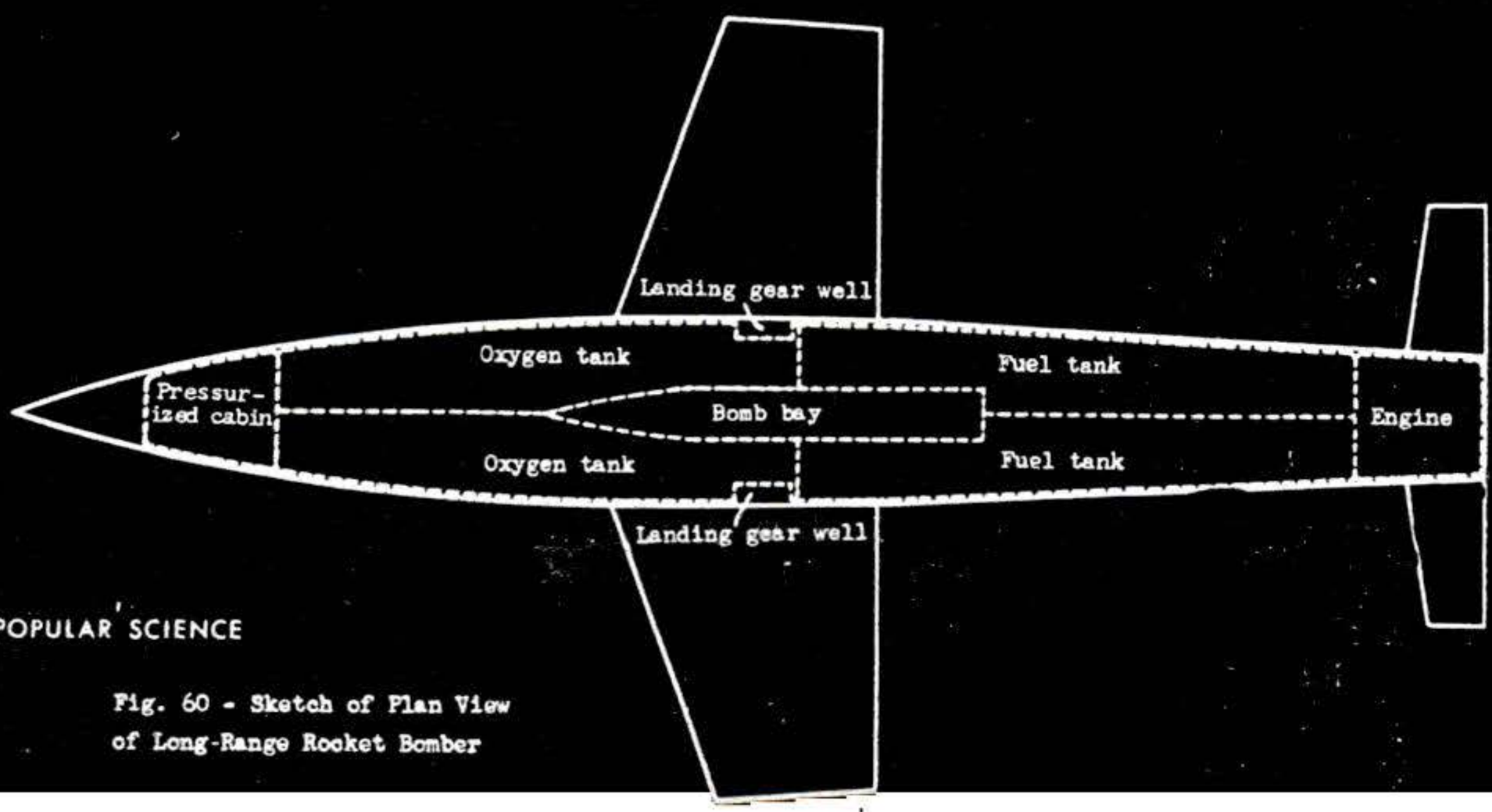

Fig. 60 - Sketch of Plan View of Long-Range Rocket Bomber

the rarefied air of the ionosphere and the heavier air of the atmosphere. The experimental model was the A-7, a winged version of the small A-5; then the A-4 (V-2) sprouted wings to become the A-8, followed by the A-9, which used acid instead of oxygen as an oxidizer. The A-9's fuel pumps were driven by a turbine using hydrogen peroxide and calcium permanganate.

Booster for Altitude

Next problem was to get the A-9 up into the ionosphere for the start of its roller-coaster journey across the Atlantic. Its own fuel supply was insufficient. The answer was the A-10, a 190,000-pound booster rocket, of which 140,000 pounds was to have been fuel. This booster was to have carried the A-9 up into the ionosphere at 2,450 miles an hour. When the fuel was exhausted, the booster could be released and the A-9 rocket motor would take over, increasing the missile's speed to 5,870 miles an hour.

Hitler's scientists, with typical German thoroughness, tried everything. They designed some 138 missiles of various types. For power plants they used reciprocating engines with jet exhaust, gas turbines, turbojets, ramjets and pure rockets. In fuels they experimented with nitric acid and mixtures of xylidines and amine compounds; others included gaseous oxygen and powdered coal for a coal ramjet.

Control Systems Galore

In the field of controls they branched out from the early method of direct wire control from a "mother" plane to the use of radio, radar, continuous wave, acoustics, infrared, light beams and magnetics. One missile had a television set in the nose. Turned on about 2½ miles from the target, it enabled controllers at the home base to direct the rocket visually at a specific building or installation, such as an ammunition dump.

Stubby and chubby, the Enzian, a radio-controlled flak rocket, was being modified for supersonic speeds when invasion intervened.

One control device refused to be controlled. In this case the missile was supposed to follow a beam of energy from a radar unit, which aimed it at an enemy target. In a test firing, however, the missile reversed itself in flight and followed the beam for a direct hit on the control station. After that the Nazi scientists favored "homing" or "seeking" devices sensitive to heat or sound.

The Nazis had other troubles, too. They were behind us in certain essential research, such as nuclear energy for warheads and alloys that would resist the terrific heat developed by rocket-powered engines. The acids they used had a tendency to corrode tanks and pipes; explosions on the ground were frequent and the fatalities high. But still there is no doubt that Hitler's scientists were 10 years ahead of us in "push-button" warfare.

Although the A-9-plus-A-10 combination was the last word in the A series of long-range missiles, all design studies and computations had been made for the next step—the true rocket bomber. Equipped with landing gear and a bomb bay, it would have been able to drop its bombs and alight after its transoceanic trip. With a liquid-fuel engine weighing 2½ tons and developing a thrust of 200,000 pounds, it was to have spanned the Atlantic from Germany to New York in 40 minutes.

Only time prevented Hitler from realizing a boast made in 1944 after watching early firing trials of his "secret weapons":

". . . These are not the product of dreamers . . . and the whole world will soon feel their effect." END

Sketches and blueprints of Hitler's supersonic transatlantic rocket bomber are taken from an official report: *German Developments in the Field of Guided Missiles,* by Col. Donald T. Putt, Army Air Forces Intelligence. Like the winged rocket (on page 108), it would have zoomed to a height of 150 miles in four to eight minutes, then continued as a gliding missile on a hop-skip-jump course. A 500-m.p.h. catapult launching was to have eliminated the need for rocket booster on take-off.

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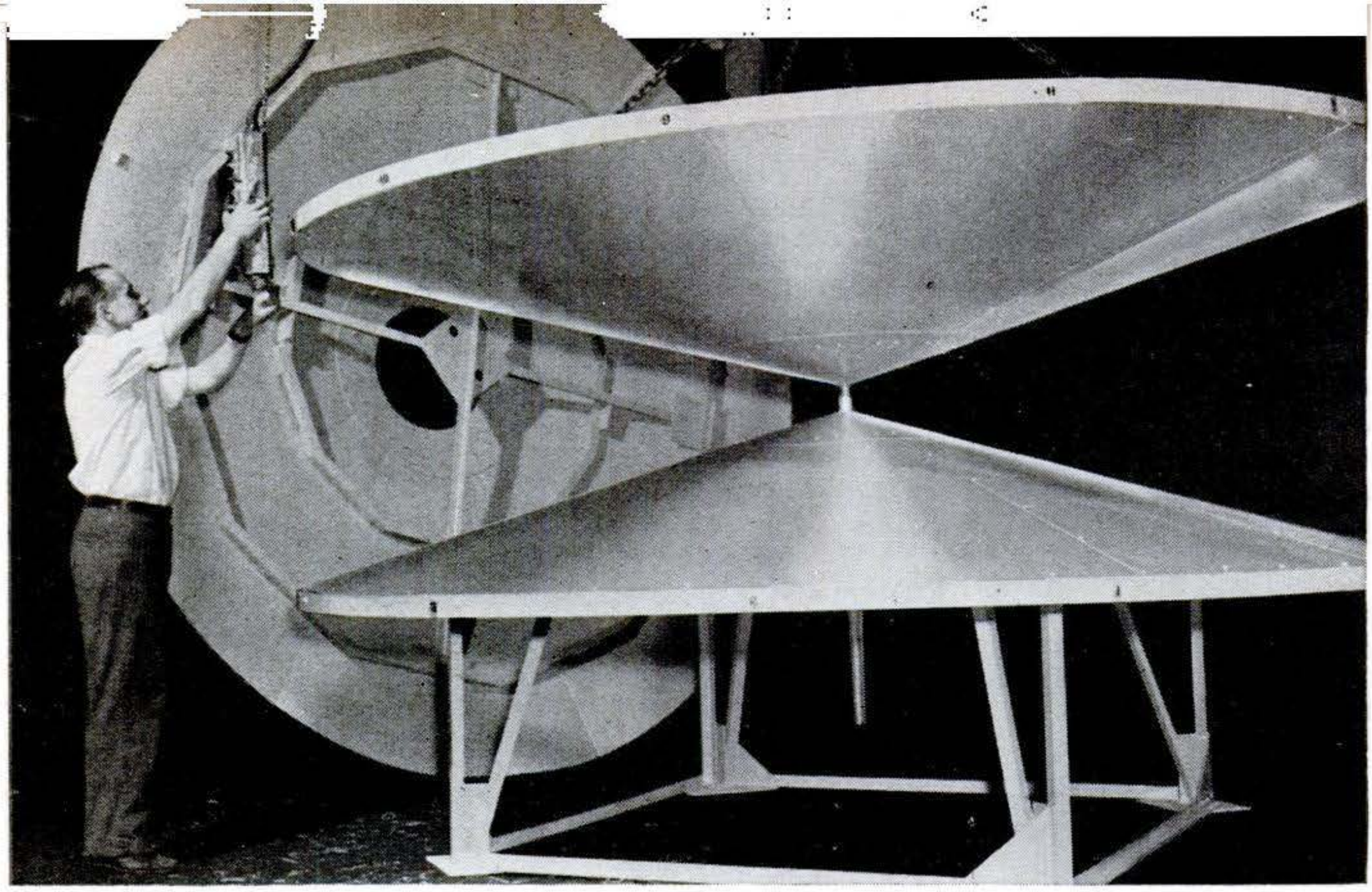
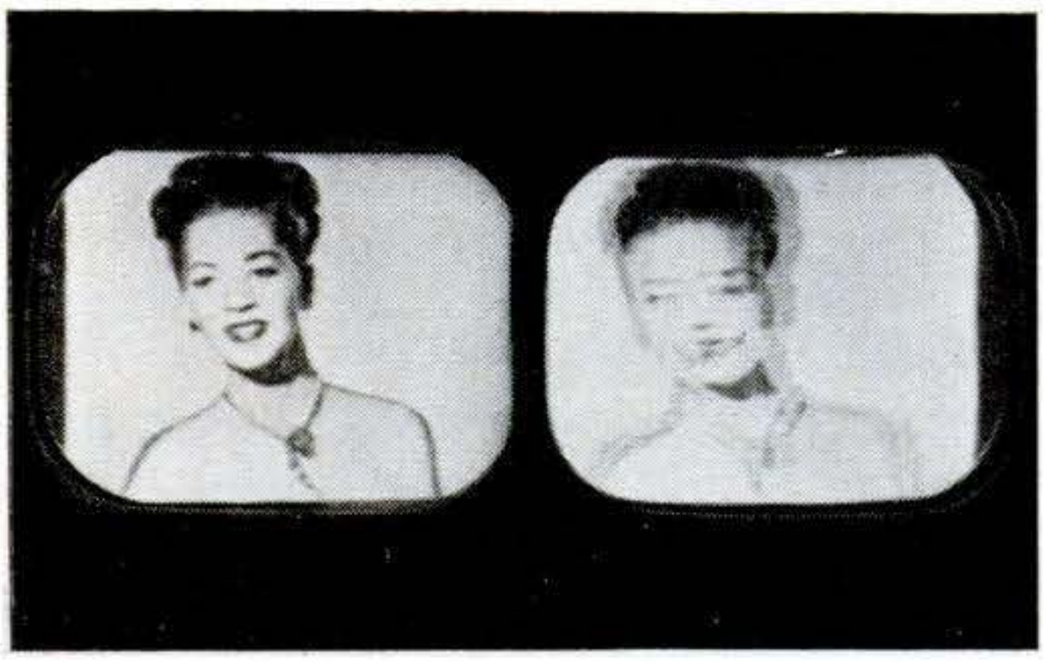
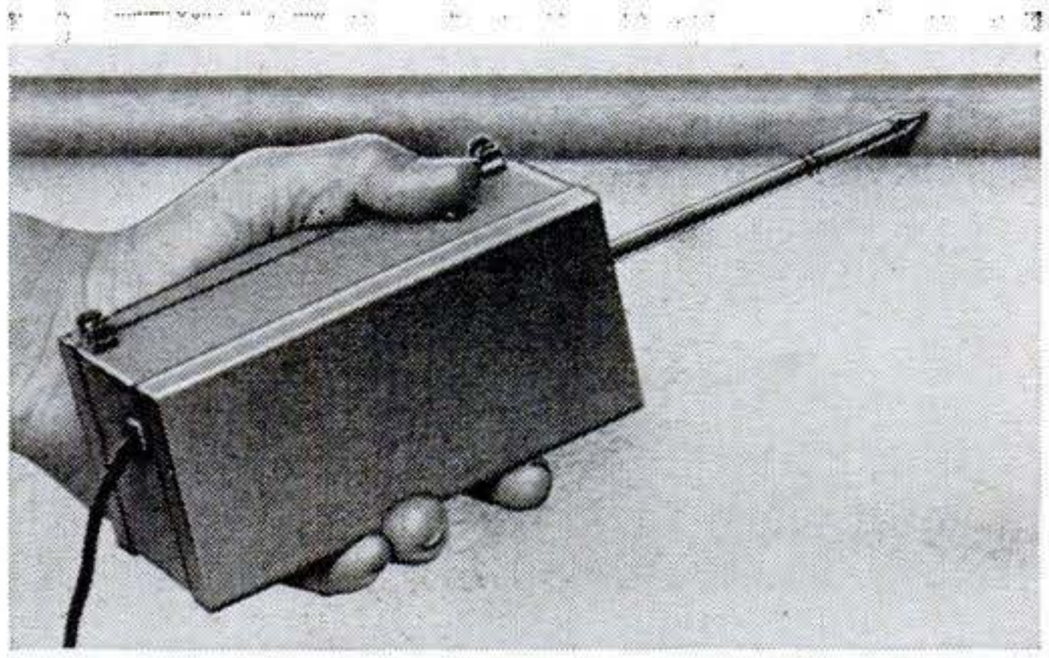


Chicken-Brooder Antenna. Because of its odd shape, this GE television antenna needs no aiming, receiving signals equally well from all directions. Said to be 16 times as sensitive as a vertical half-wave type, it will pick up telecasts of Washington, D. C., news events from mobile transmitters for rebroadcast by WMAL.



Pay-as-You-Look Television. "Phone vision," developed by Zenith Radio Corporation, offers paying television audiences the cream of latest stage plays and movies. A combination home receiver brings in free programs as usual. Special features reach it partly by air, partly by phone line. Blurred when viewed alone (above, right), the radio image becomes clearer (left) with key frequencies received by phone. "Admission charges" go on phone bill.



"Electric Ear" Finds Leak. Locating the trouble spot in a defective pipe becomes easy with a detector introduced by the Fisher Laboratory, Inc., of Palo Alto, Calif. Applied as shown, its metal tip picks up vibrations caused by water escaping through invisible leaks. A battery-powered crystal pickup amplifies the sound for an operator wearing earphones. Using a long tip, he can test buried pipes. The device is designed not to respond to traffic noises.

This Month's Pin-up →

Six gas-turbine engines propel Martin's XB-48, new AAF high-speed jet bomber, at more than 480 miles an hour. Three men fly it. Bomb capacity tops 10 tons, and tactical radius exceeds 800 miles. Shaped ultrathin for speed, wings have 108-foot span. Main wheels in tandem retract into fuselage, outrigger wheels into wings.

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Radio Makes the Varsity

The stations of the Intercollegiate Broadcasting System have only a 200-foot range—but lots of punch.

RADIO broadcasting has joined campus newspapers and athletics as a big-time activity for American college students. Already more than 50 schools in the United States and Canada have their own stations, operated by and for students only.

By using a trick method of transmission that limits reception to selected campus buildings, the collegiate broadcasters remain free of most of the federal regulations restricting commercial stations. Standard studio equipment—microphones, turntables, amplifiers, etc.—is employed, but the radio-frequency transmitters are usually of very low power and the antennas are radically different. Instead of a single antenna located near the transmitter, these "limited-area-coverage" stations have a whole network of antennas around the receivers—usually the lighting circuit in the building.

Waves from these elongated antennas are easily picked up inside the building, but cannot be detected beyond about 200 feet. This extremely short range puts the college broadcasters outside the legal definition of a "standard radio station," but the Federal Communications Commission keeps a watchful eye on their activities. Since the greatest range a station can produce without needing a license increases as the frequency decreases, most of them operate in the lower end of the broadcast band, between 550 and 700 kilocycles.

Many of the colleges have elaborate installations, with several studios, large student staffs and costly equipment. Considerable technical skill (usually furnished by a faculty adviser) is needed for operation, and even more for the initial construction work. Unless precisely engineered, the systems will broadcast either with insufficient power or so much that the FCC points an accusing finger for operating an illegal "standard" station.

To avoid these dangers, most schools use the engineering service of the Intercollegiate Broadcasting System, an association including nearly all the college stations. IBS also arranges for advertising (which runs to six figures annually), exchanges program scripts and transcriptions, and operates two regional networks that link as many as 19 stations with leased wires.

The most popular programs are classical music—generally recorded—broadcast during study hours.

The pioneer limited-area-coverage station is WBRU at Brown University, Providence, R.I. It was founded in 1936 by two student hams, George Abraham and David Borst, now officials of IBS.

Student interviews are a feature of station WVBR, which broadcasts from Willard Straight Hall at Cornell University.

"Speaking of Records" is one of WVBR's special programs. Joel Chaseman, in background, plays and discusses jazz.

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Students at St. Lawrence University, at Canton, N. Y., broadcast a play over station KSLU.

Princeton's WPRU, a member of IBS, broadcasts a running account of a football game from the stadium press box.

Technical maintenance is usually done by students, as here at Cornell, but IBS provides the installation services.

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Tomorrow's Missiles Take Off

The hitting power of a light cruiser's salvo nestles under the wings of this Douglas AD-1 Skyraider. In the line-up are 12 six-inch rockets, two 12-inch Tiny Tims and a 2,000-pound aerial torpedo. This three-ton knockout punch is fired by a 175-pound mechanism that can also be used to carry fire bombs, radar or extra tanks of gas.

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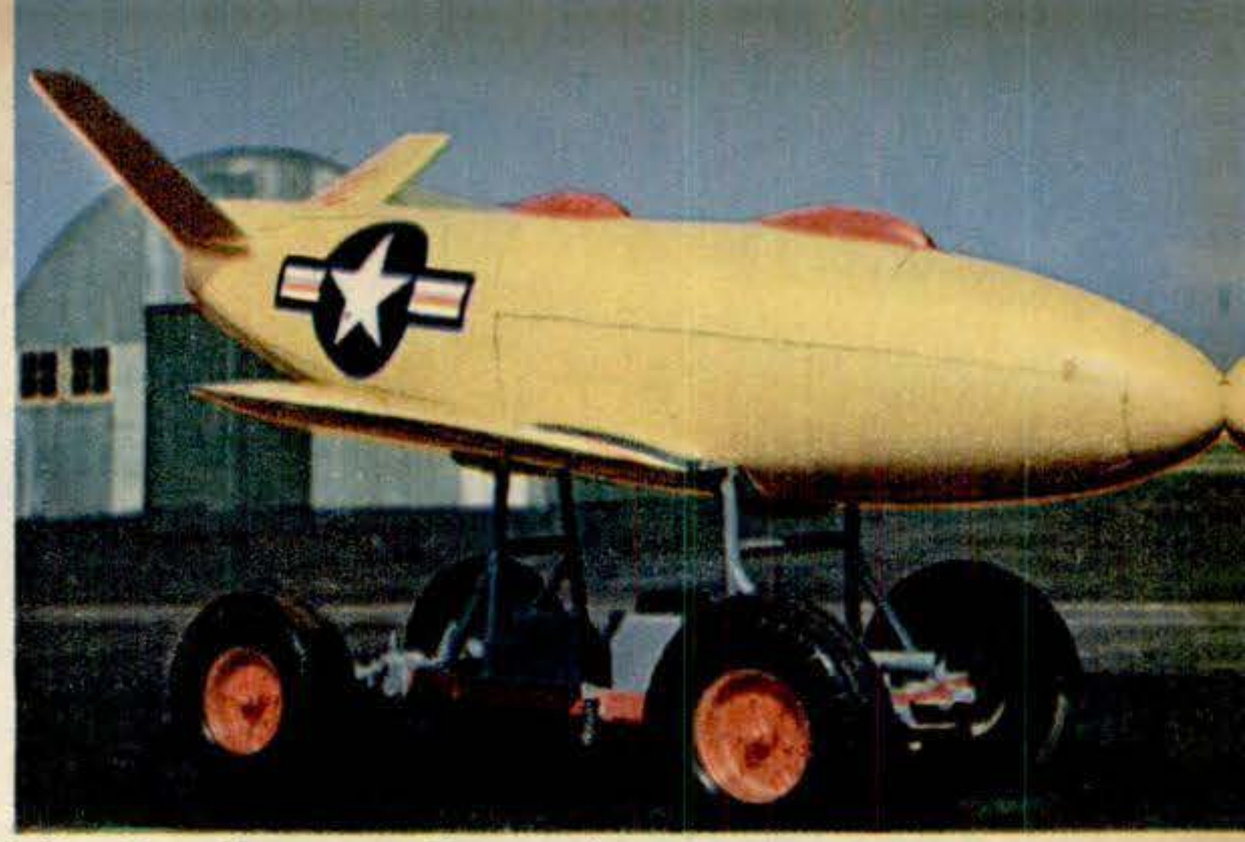
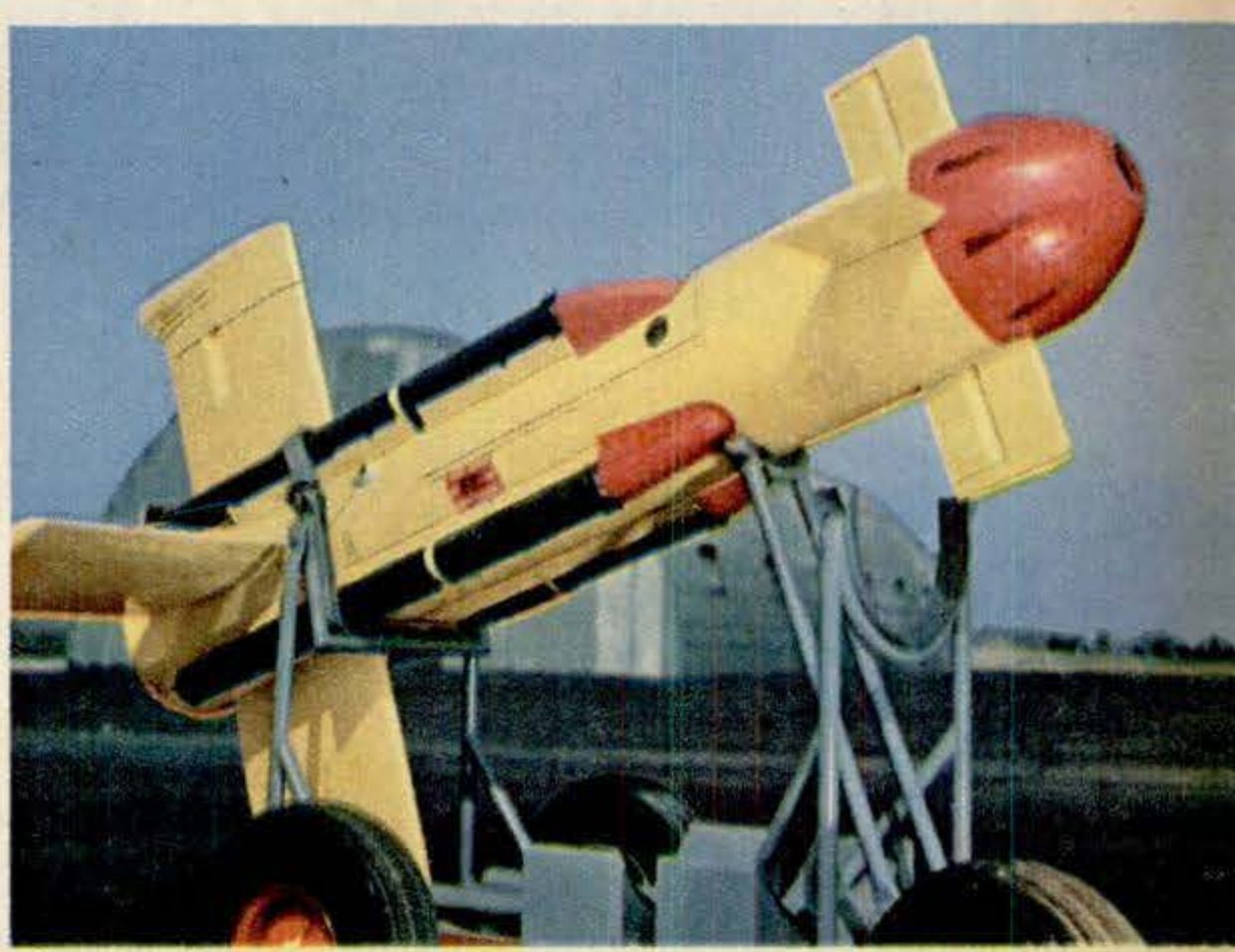
TOMORROW'S Navy will be ready to fight with weapons as deadly accurate as William Tell's arrow. Successors to the carronade and Dahlgren gun are such characters as Little Joe and the Gargoyle. Some are guided missiles, some are planes, some are power-packages. All fly regularly out over the Pacific from the Navy's Air Missile Test Center at Point Mugu, Calif. Each run is tracked by radar and telemetering devices. Some units are preset, unalterable once flight commences. Others, with their own radar to detect and steer for the target, are fiendishly accurate. Command-system missiles are usually radio-controlled; course-seeking missiles are directed by light beams or radio energy.

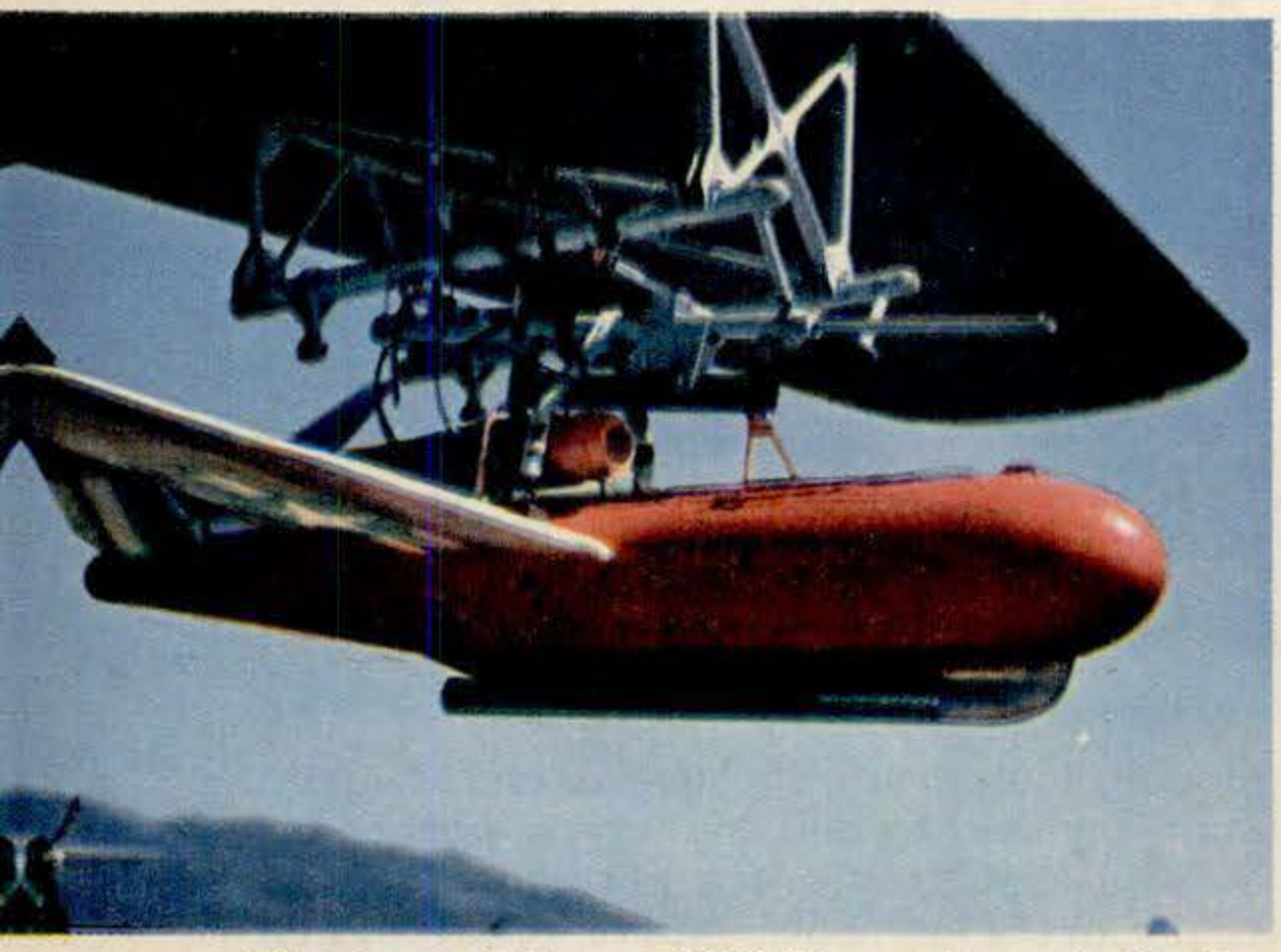


The bomb-toting Gargoyle (KUD-1) is carried by a mother plane for use against moving targets. Guided visually, it is driven almost as fast as sound by a Jato unit.

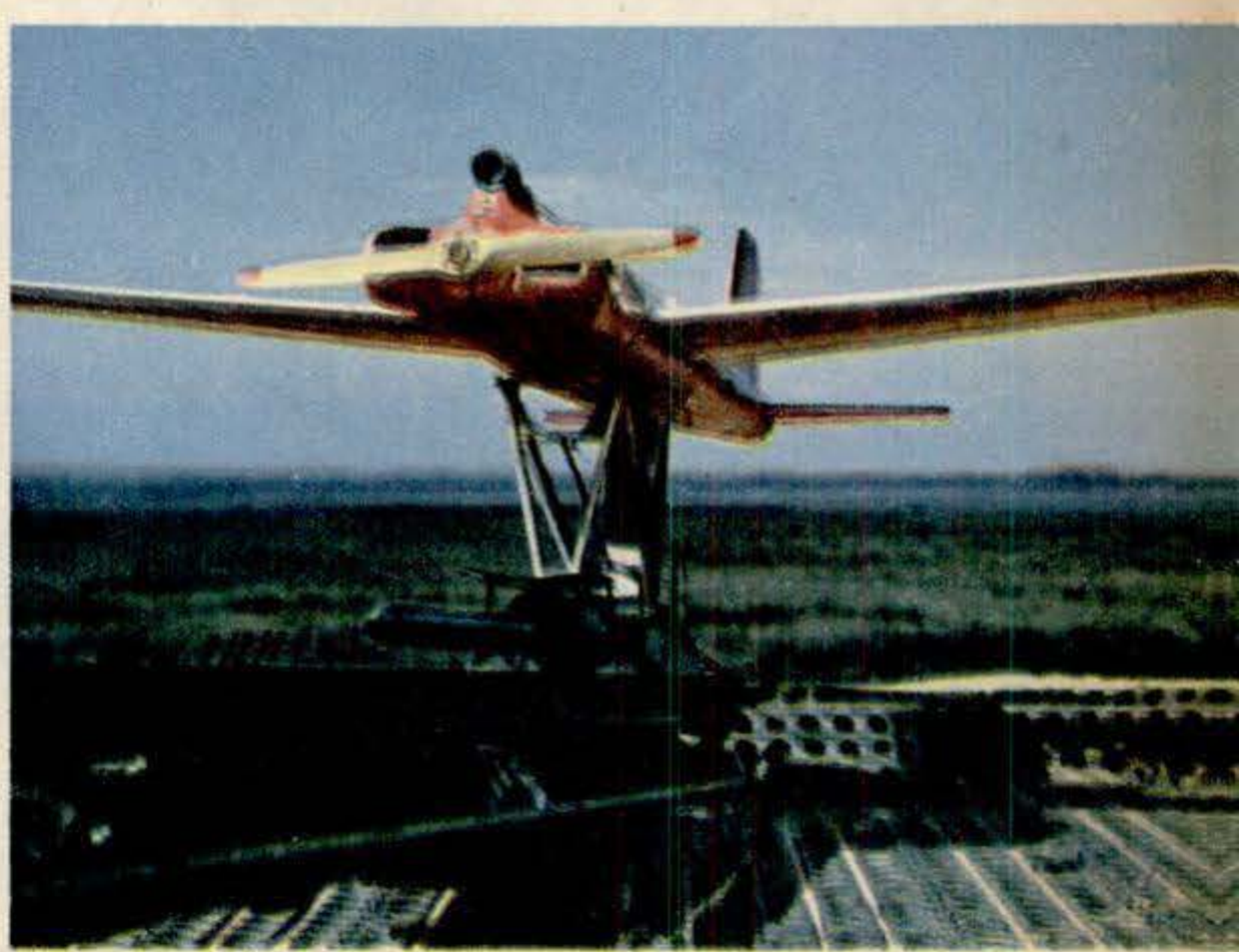
The Gorgon (KU2N-1) is fired by aircraft against other aircraft. It is a radio-controlled flying bomb, rocket-motor powered, detonated by contact or remote control.



Little Joe (KUN-2) is fired by ships against aircraft. A short-range, radio-controlled missile, it carries a single bomb. Four rockets help it take off from shipboard.



The target drone KDD-1 exists only to be shot at. An eight-inch pulse jet gives it 230 m.p.h. It can be launched from a mother ship or catapulted from the ground.



KDR-1 is the standard Navy target. Powered by a 35-hp. Kieghaefer reciprocating engine, it makes 190 m.p.h. It is radio-controlled. Here it is about to be catapulted.

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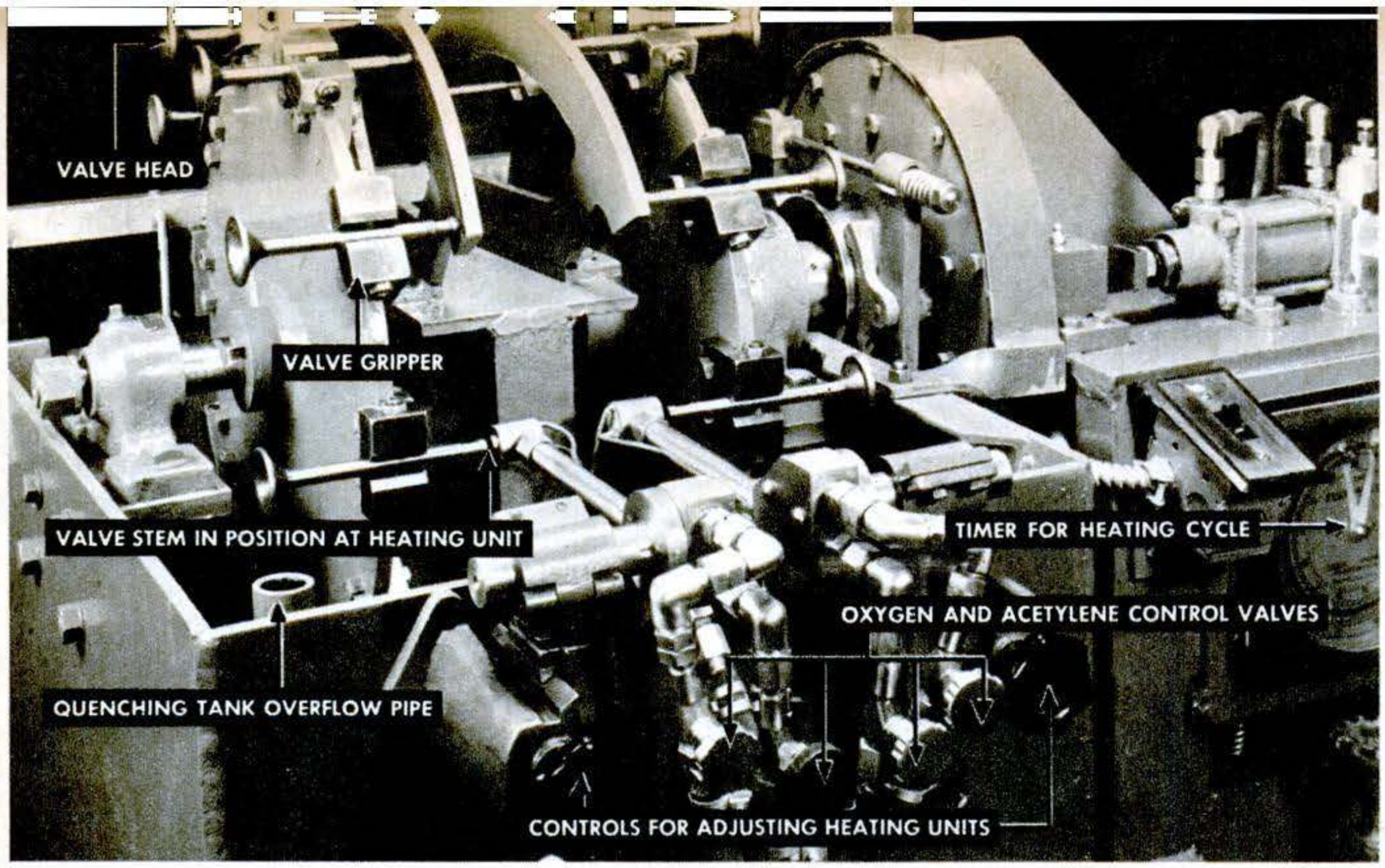

Machine "Cooks" Valves

FLAME-HARDENING of valve stems, long a laborious and uncertain hand operation, is done automatically and uniformly by the new Canadian machine shown above. Every four seconds, it turns out two valve stems toughened to withstand the battering wear of internal-combustion engines.

Developed for Thompson Products, Ltd., by the Dominion Oxygen Co., both of Canada, the machine has metal clasps equally spaced around twin metal disks rotating axle-deep in a quench tank. Valves are fed into the clasps (the only manual operation required), and as the disks turn the valve stems move into position before oxyacetylene flames. After four seconds, the disks move again to heat two new stems, plunge the hot ones into an oil-and-water quenching bath, and bring up two finished valves from the opposite side of the tank.

Earth-Movers Try Coal

FACED with the wartime problem of handling about 650,000 tons of coal annually with restricted facilities, the Polymer Corporation's synthetic-rubber plant at Sarnia, Ont., came up with the idea of using earth-moving equipment. The 'dozers and scrapers, supplemented by belt conveyers, worked out so well that they got a permanent job as coal-movers, as shown above. Coal, lighter than earth, doesn't strain the machinery; it even helps lubricate moving parts that dirt would abrade.

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Sketch shows how the underground hydrants are used for direct servicing. With one unit handling each set of wing tanks, even largest planes refuel in a few minutes.

Fuel Pits Fill Planes Pronto

WITH speed as their stock in trade, air lines are constantly striving to make ground operations match the tempo of their pace aloft. One of the latest tricks to reduce airport delays is a system of underground fueling pits, installed at San Francisco's Municipal Airport, which enables a DC-6 to fill its 4,200-gallon tanks in 10½ minutes and eliminates the need for cumbersome gasoline tank trucks.

The pits are fed by 13,000-gallon tanks, above ground, which are automatically refilled from a million-gallon tank farm. The underground units include pumps, flow meters and canvas hoses mounted on hydraulically operated reels. A 4,000-gallon differential in each tank saves additional time by allowing planes to empty their tanks back into the supply system in preparation for any mechanical servicing.

Using portable ladders for access to wing tanks, airport workers can fuel planes directly from one of the underground hydrants if the pit's hose is long enough. For remote fueling, a special hose truck with hydraulically operated ladder and reels provides a speedy connection between plane and hydrant. Pressure in the hose is regulated, and the amount of fuel pumped into a plane is registered by an electrically controlled nozzle that is able to handle up to 250 gallons of gasoline a minute.

A hose truck provides link for planes some distance from a pit. Here a member of the fuel crew attaches hose to hydrant. Next he will extend hose on other reels to plane.

Hauled up truck's ladder, the hose is ready to feed tanks 250 gallons a minute. System was devised by United Air Lines, Standard Oil of California and the Wayne Pump Co.

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Appointments of the new Presidential plane, the *Independence*, make swift travel safe and

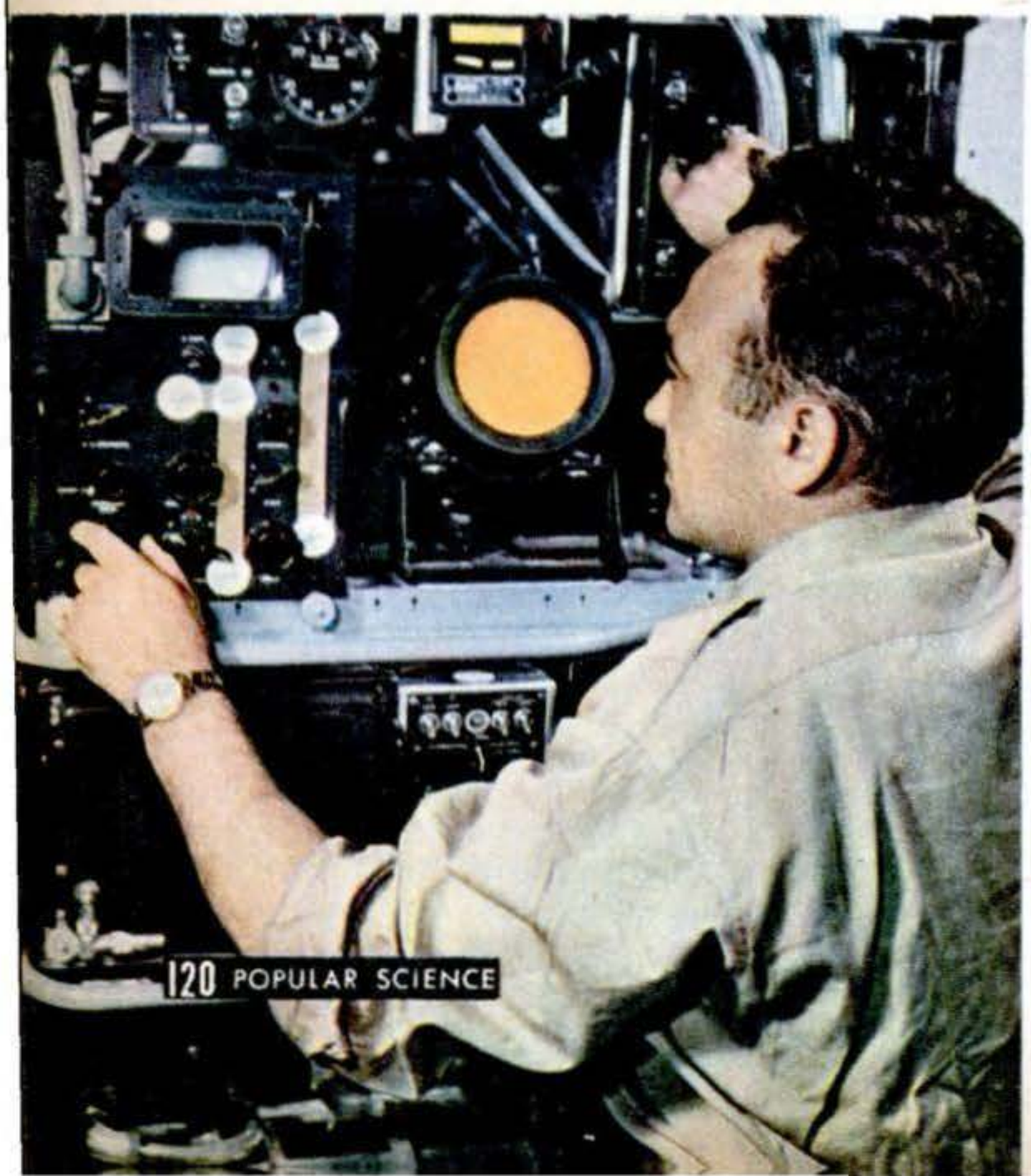
"White House" To Roam Sky

Luxurious new *Independence* replaces the travel-worn *Sacred Cow* to speed President's aerial travels.

WHEN the President of the United States travels, a 315-mile-an-hour plane speeds him swiftly and safely to his destination.

Named the *Independence,* after President Truman's home city in Missouri, the special new Douglas DC-6 cruises 100 miles an hour faster than the *Sacred Cow,* the DC-4 that carried Presidents Roosevelt and Truman and other high officials to 55 nations in trips totaling 431,000 miles. Extra gasoline tanks give the *Independence* a range up to 4,400 miles, and a pressurized cabin permits high-altitude flight. A blue-and-tan exterior design, representing the American eagle,

Safety devices of every known type include a special airborne radar installation, with orange screen at center of panel on which terrain may be observed in spite of fog.



Teletypewriter set automatically codes and decodes confidential radio messages between the President and his cabinet advisers in Washington. It has range up to 3,000 miles.

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comfortable for the Chief Executive and his party. A crew of eight mans special DC-6.

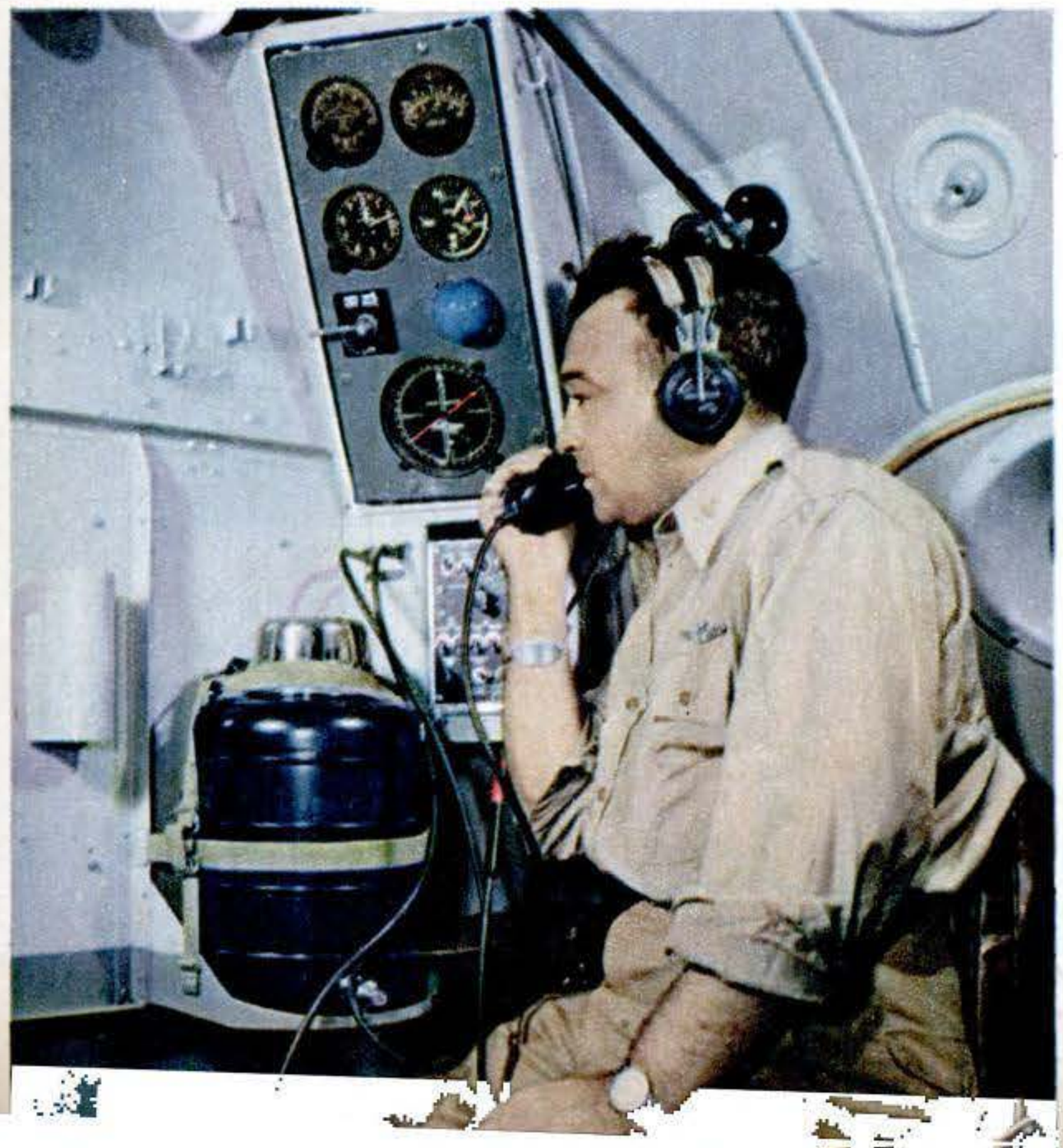
outwardly distinguishes the flying White House from other craft of its type.

Navigating equipment includes every known safety aid. A special radar set gives a constant view of fog-hidden terrain, while a radio altimeter, taking echo soundings, precludes danger of collision with mountain peaks. When making overwater flights, the plane carries life rafts and life-preserver vests.

The handsomely furnished Presidential stateroom occupies the entire fuselage aft of the entrance door. The President's swivel reclining chair faces a mahogany conference table inlaid with the Great Seal of the United States. A telephone handset and controls of a concealed radio put the world's capitals at his fingertips. He may also exchange confidential messages with his cabinet advisers in Washington by radio teletype, which scrambles the messages to prevent unauthorized interception. Across the cabin, a large built-in sofa becomes a full-sized bed at night. A lounge aft of the stateroom serves as a dressing room.

Passenger accommodations provide upper and lower berths for 12 persons, or seats for 24. A galley with electric stove and electric refrigerator serves the Presidential party hot meals aloft. END

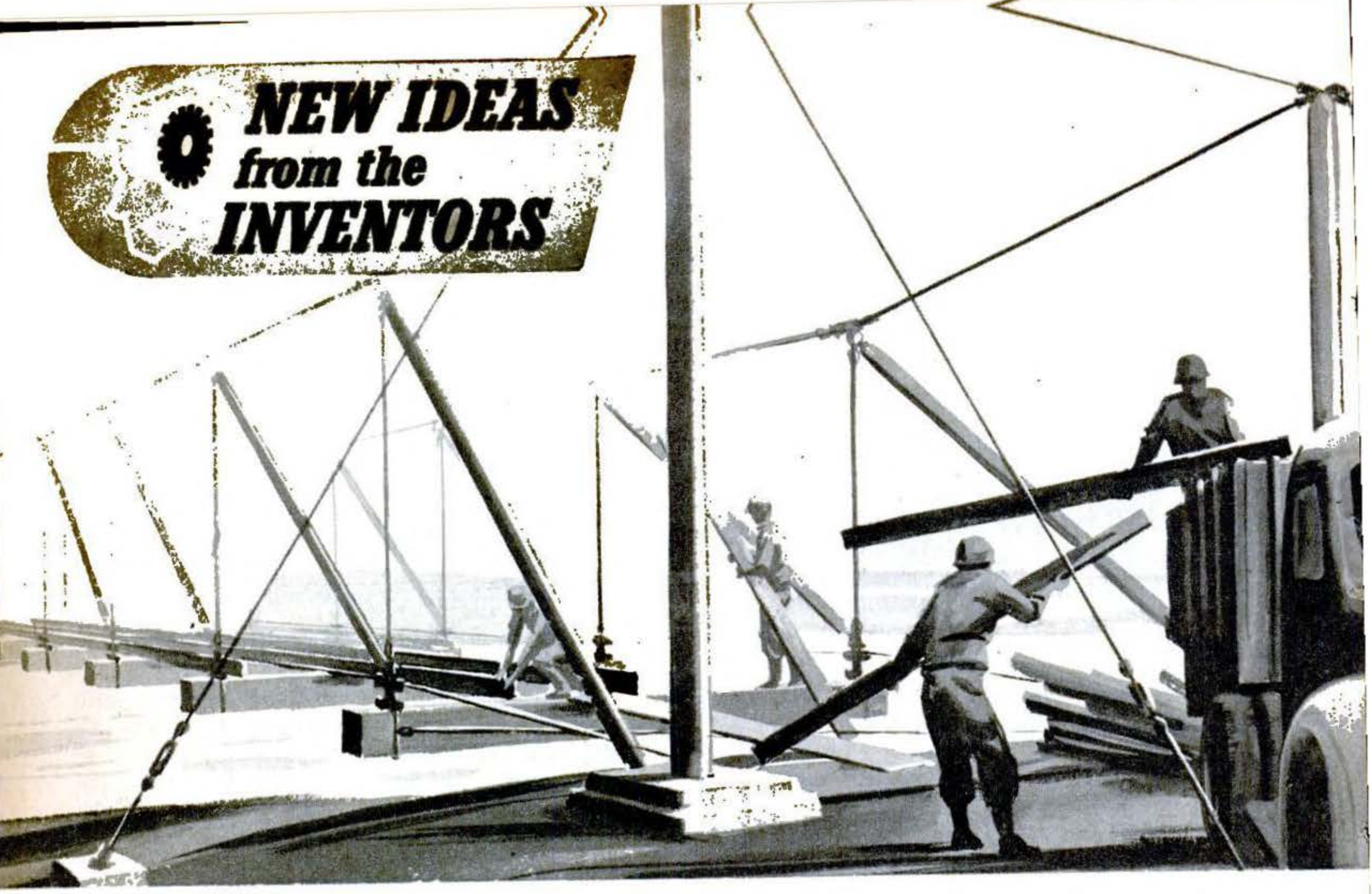
Navigator may call weather stations anywhere on earth for up-to-minute data. Instruments above vacuum jug include altimeter, radio compass and air-speed meter.



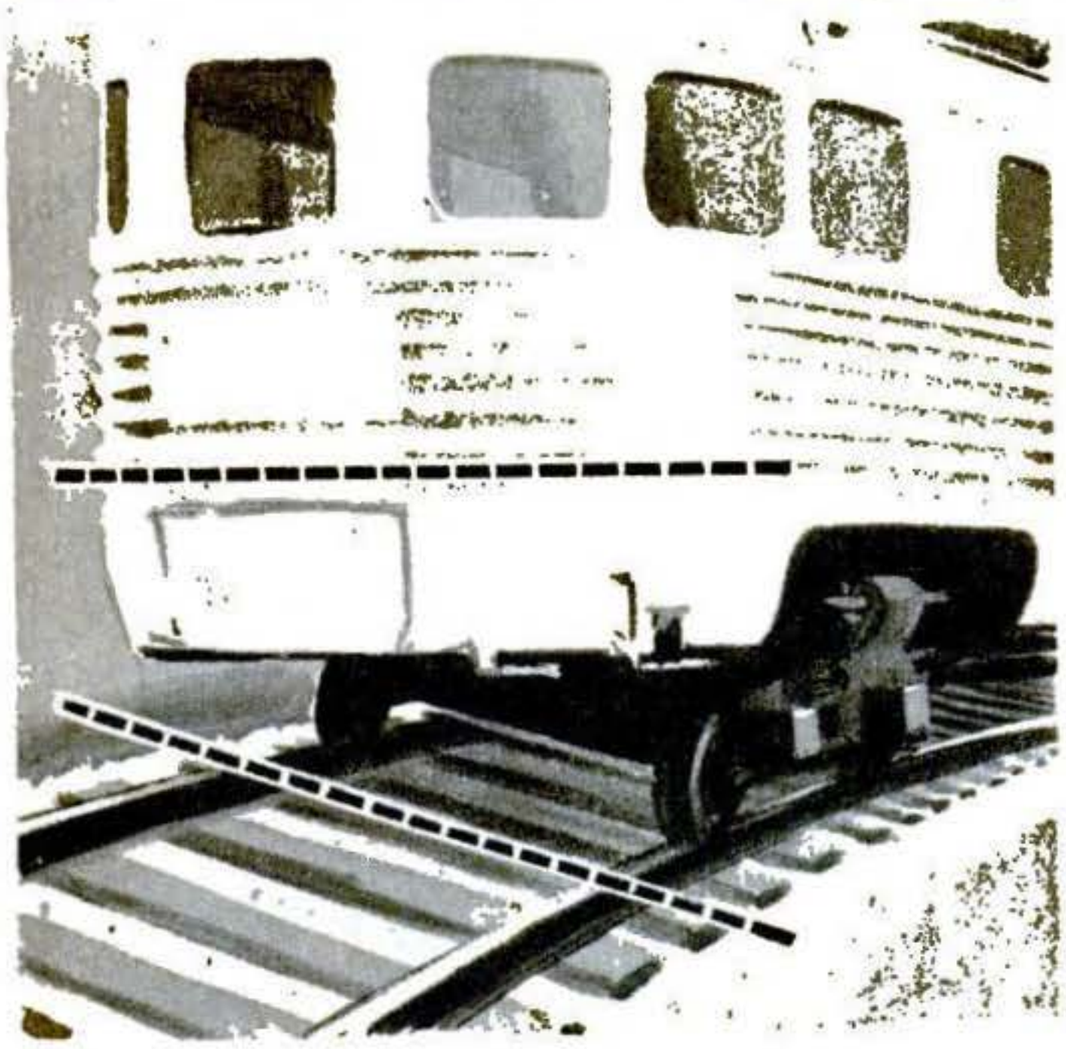
The crew of the *Sacred Cow,* former Presidential plane, will also fly the new *Independence,* shown below. Eagle's-head design in blue and tan decorates four-engine craft.

Kodachromes by Lew Nichols

NEW IDEAS from the INVENTORS



Booms Build Bridge. Like a series of derricks, each supported by the one preceding it, this novel military bridge is formed of identical boom sections suspended from anchored masts and held rigid by cross-bracing. Invented by Edward F. Janke, Sr., of Washington, D. C., the bridge can be long or short, depending on the number of booms used. Simplicity of parts permits rapid, unskilled assembly and repair.



Coach Levels Itself. A device to keep railroad cars level on banked curves and uneven roadbeds is the invention of Carleton K. Steins and William M. Keller, of Merion, Pa. Actuated by a weighted pendulum, it compensates for any slant in the tracks by tilting the body of the car through an equal angle in the opposite direction.

Extra Grip Aids Lift. Two handles are better than one, believes George A. Spencer, of North Platte, Nebr., inventor of a shovel that has a second handle near its scoop. Designed to be held in one hand while the regular handle is grasped by the other, the extra grip distributes the shovel's weight evenly to permit easier carrying.

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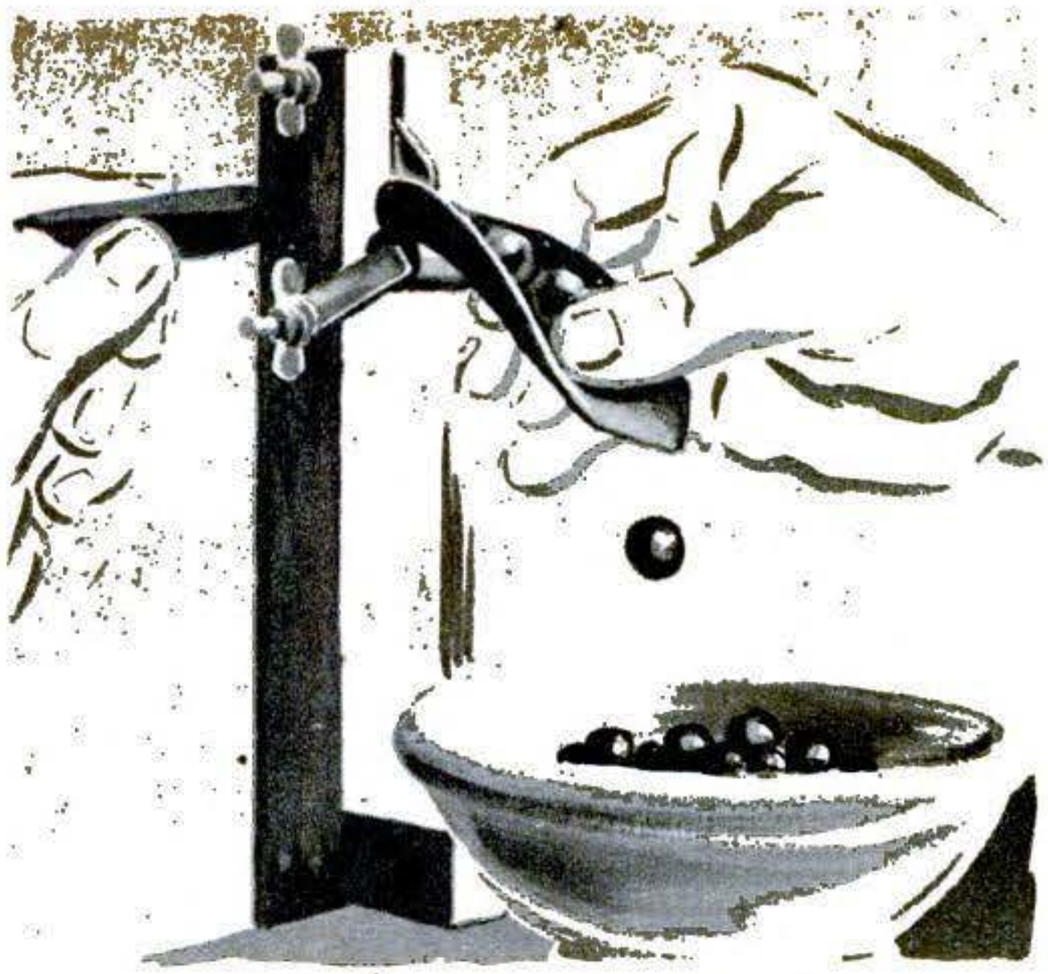
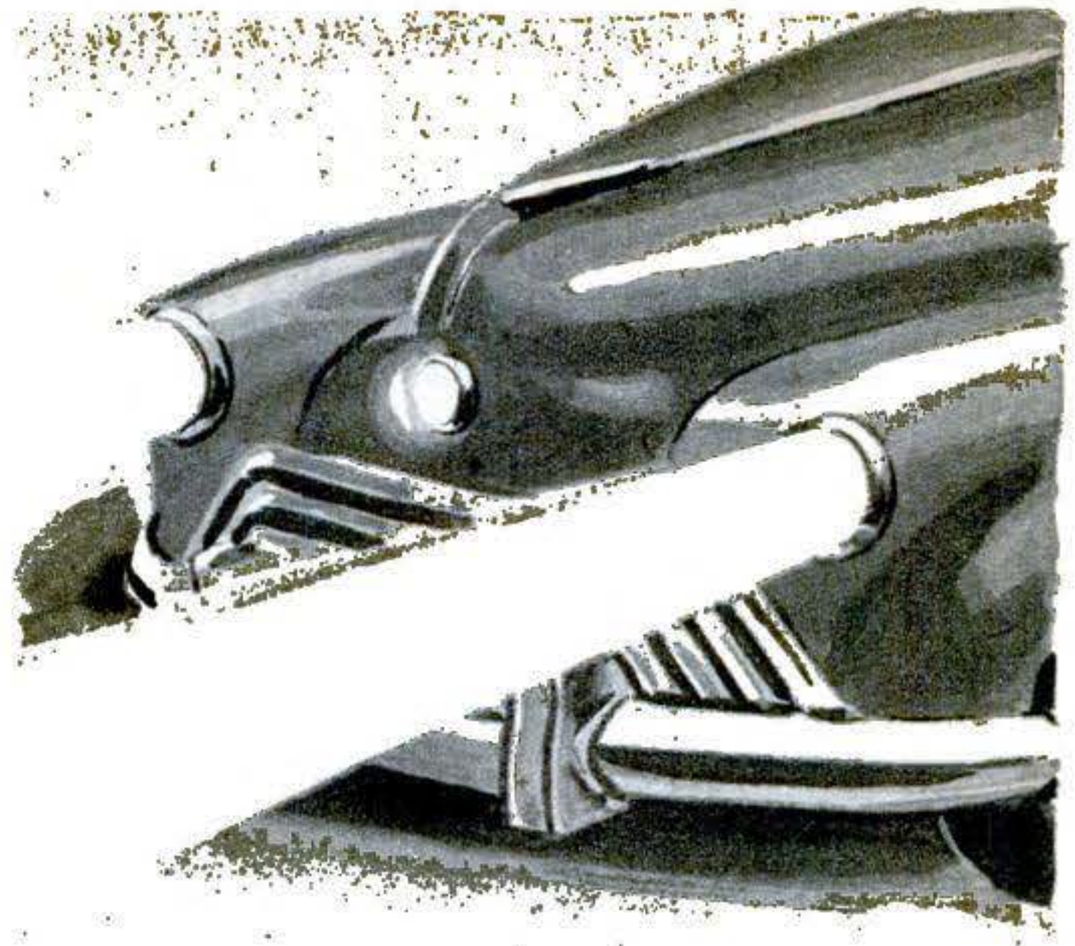


Pea Sheller Splits Pods. Peas and beans are quickly removed from their pods in this invention of George D. Evernden, of Dallas, Tex. As the pods are passed through the hole in the upright stand, a blade held in the slot above slits them lengthwise. An adjustable roller, over which the split pods are then pulled down, spreads them apart to release their contents.



Signal for Dim Headlights. To show the driver of an oncoming car that your headlights are already dim and eliminate the nuisance of having to flicker them, Thomas M. Johnston, of Washington, D. C., has devised a small signal light. Placed between the headlights, it would remain lit (preferably showing a distinctive color) whenever the dim beams were in use.

Cushions to Soften Crashes. To protect the occupants of an airplane from the impact of a crash, Arnold Whitmer, of Buffalo, N. Y., has invented inflatable cushions designed to check passengers' forward motion and keep them from striking hard objects. Primarily for use in forced landings, where the impact may not be sufficient to demolish the plane but is liable to cause serious injuries, the cushions are stored, folded and deflated, beneath the seats when not in use. When a crash is imminent, the pilot releases a master control that inflates all of them simultaneously. Their curved, horseshoe shape is intended to keep passengers from being thrown sideways.

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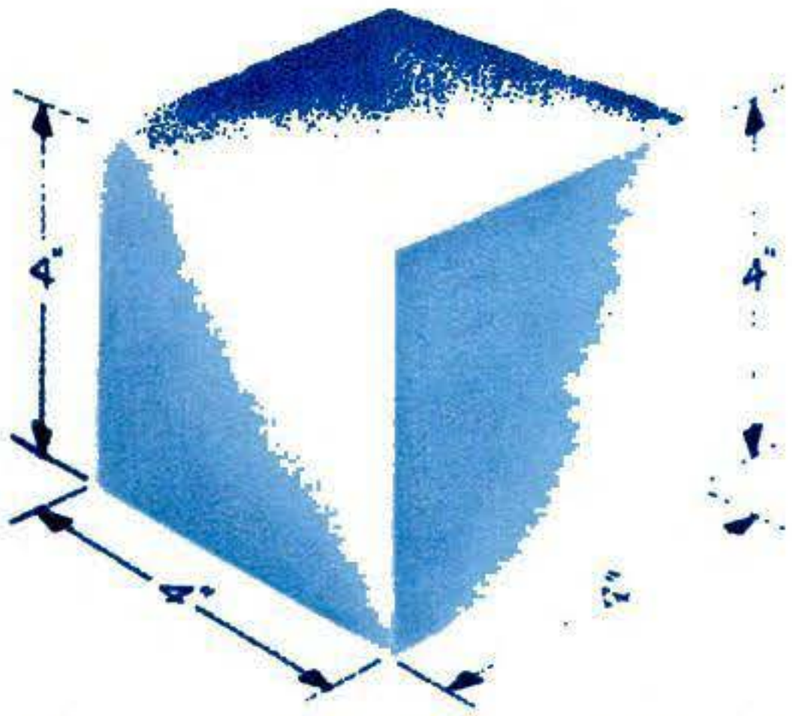
By Hartley E. Howe

Housing Cost Cut by New Cubic Unit



THIS is a picture of a module. No one has ever seen a module, except in a picture. No one has ever touched it. In fact, it has no physical existence. But the module will save millions of dollars in America's postwar housing. And it can help to build *your* house cheaper—and better.

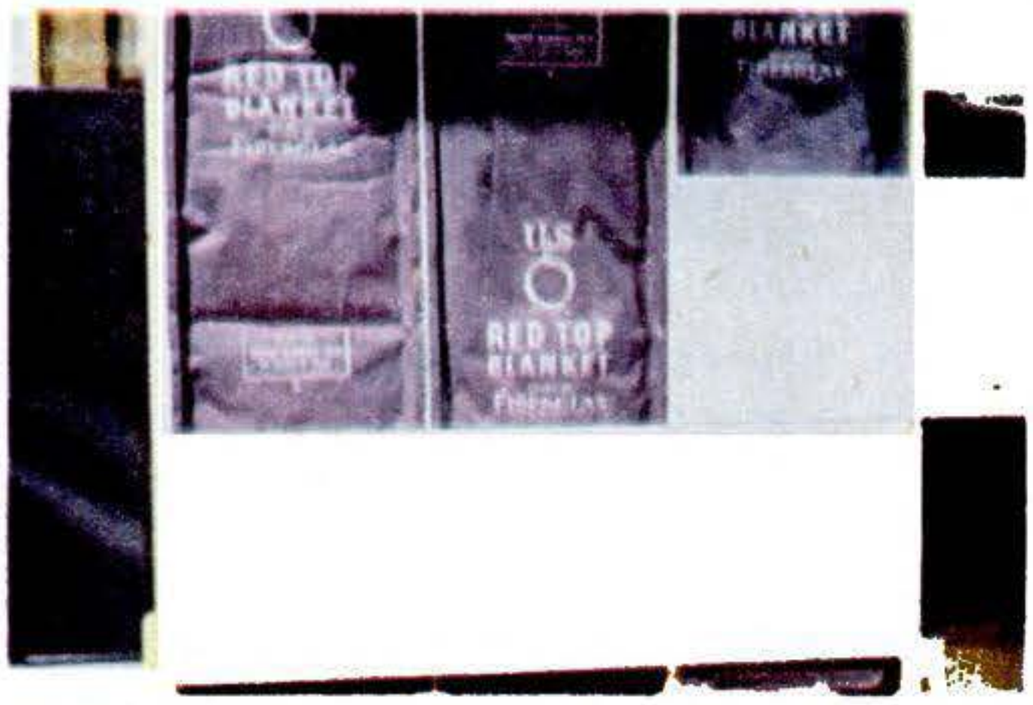
Have you ever noticed the trash piles around a building job? That waste is one big reason why you pay more for less housing. Behind it is a tradition of muddle, which the module breaks.

Imagine a group of workers trying to assemble an automobile. The wheels come in ⅛" sizes; axles in .2", so they don't quite fit; a couple of men must set to work with files. New England-made windows and Middle Western frames are the same nominal size, but their actual dimensions differ; out come glass cutters. Fenders are standard but the designer wants flare, so they are hammered to match the blueprint. . . .

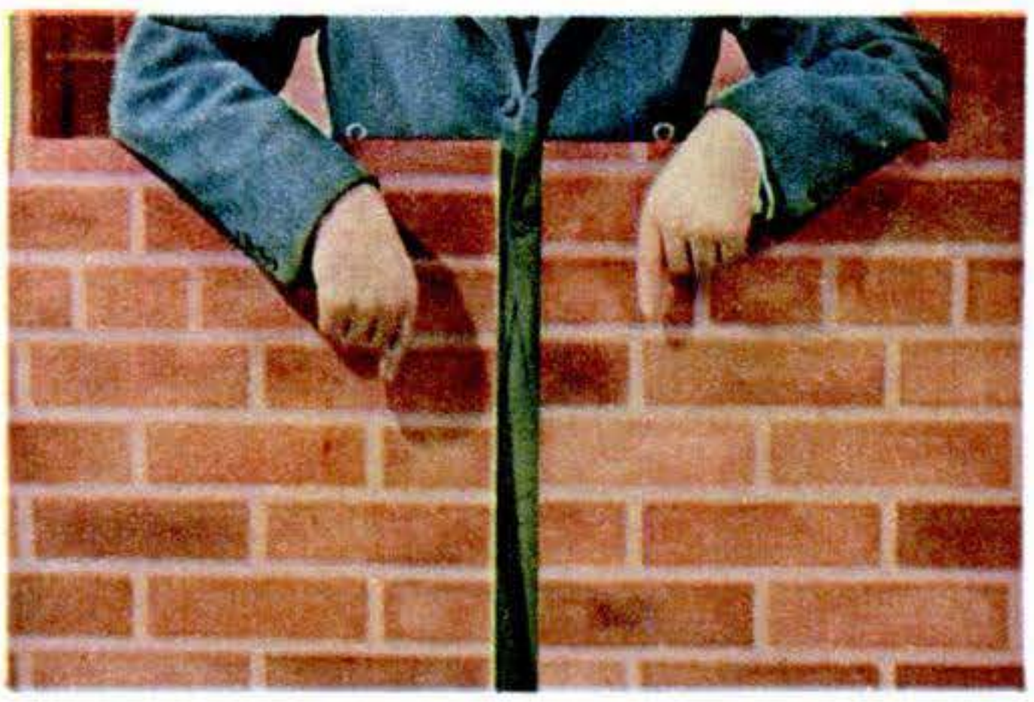
Make your hair stand on end to think how much a car built that way would cost? That's the traditional way to build a house. Every building-product manufacturer had his own sizes, related only by accident to products used with his. List sizes were (and are) nominal; actual sizes of the same product varied sectionally. Until recently there were 10 different wood-window "markets," each with its own actual sizes; you were out of luck if you tried to fit a window from one into a frame from another. To top this confusion, the architect chose di-

Color photographs from a slide film prepared by A. Gordon Lorimer, A.I.A., under sponsorship of American Institute of Architects and Producers' Council, Inc.

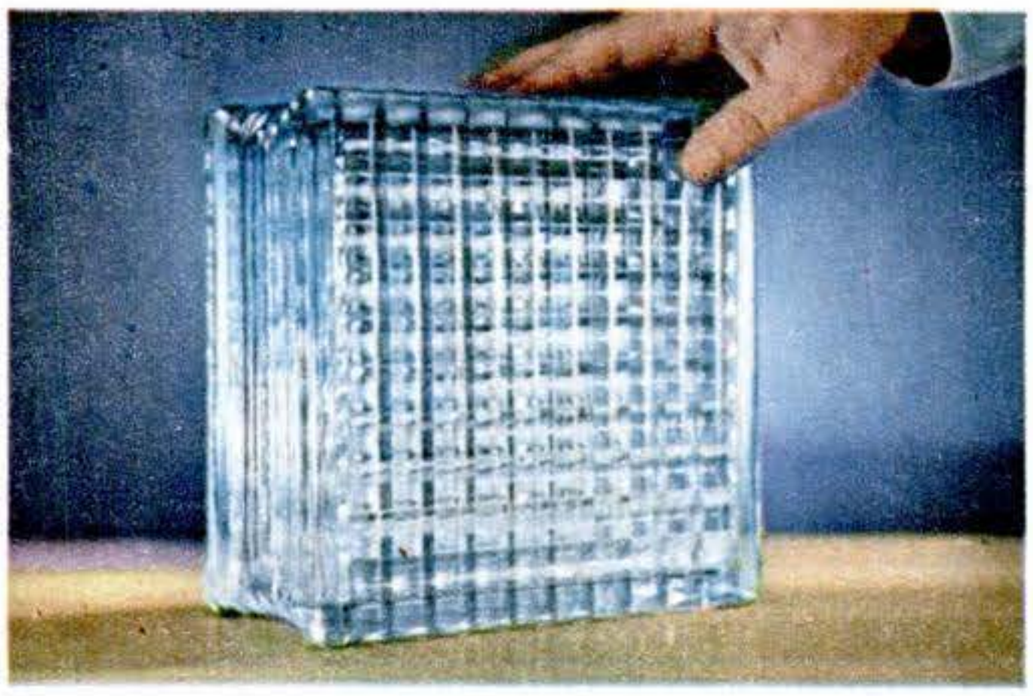
1. Blazing trash pile near a building site means somebody's money is going up in smoke. All wasted material was paid for.



4. But insulation fits and construction board joins at fourth stud without cutting. These products were *co-ordinated* with wall.



7. To the eye, modular brick looks just like ordinary brick. Here are the two side by side. Can you tell them apart?

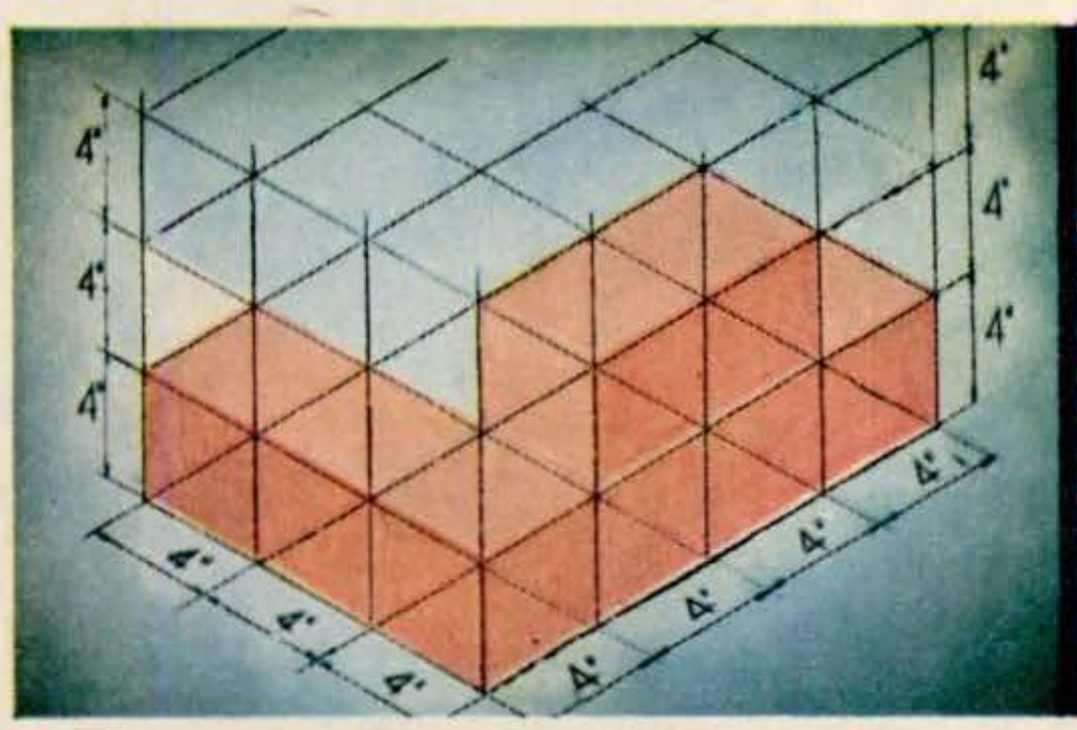


10. Glass brick makers were among first to use module. This brick is 7¾ by 7¾ inches—two by two modules, with joint.

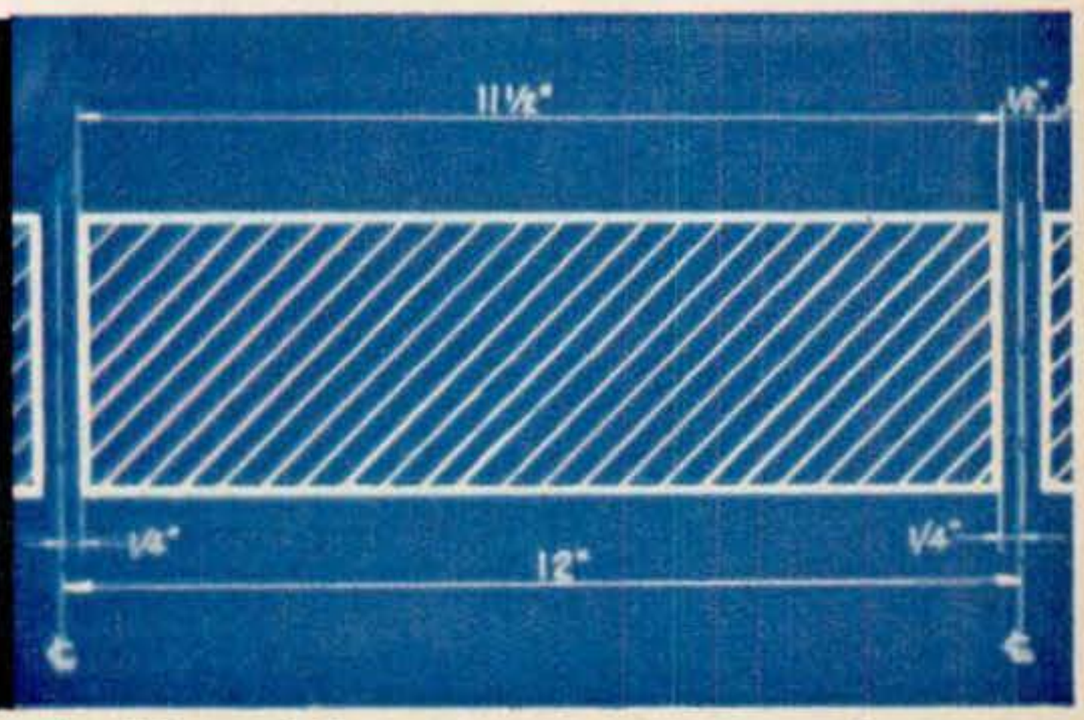
Copyrighted material

2. More money went into cutting off the scrap. It takes this man three to five minutes to slice each tile to make it fit.

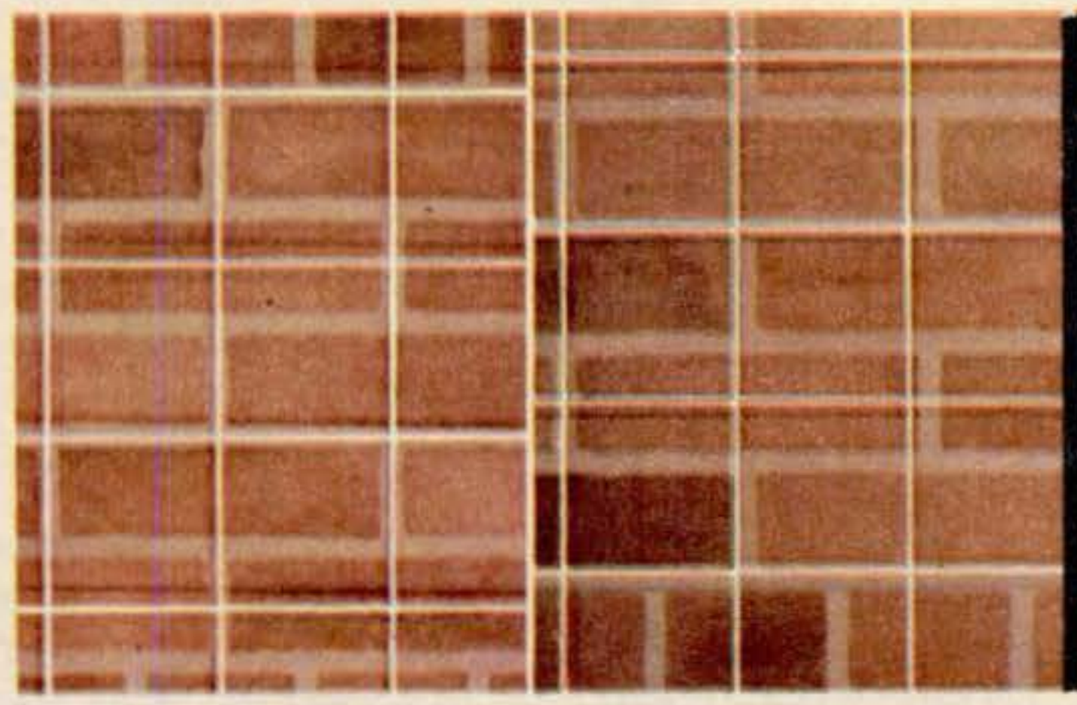
3. Now look at this tiled wall—and see how many tiles had to be cut around the doorway and fire-extinguisher niche.



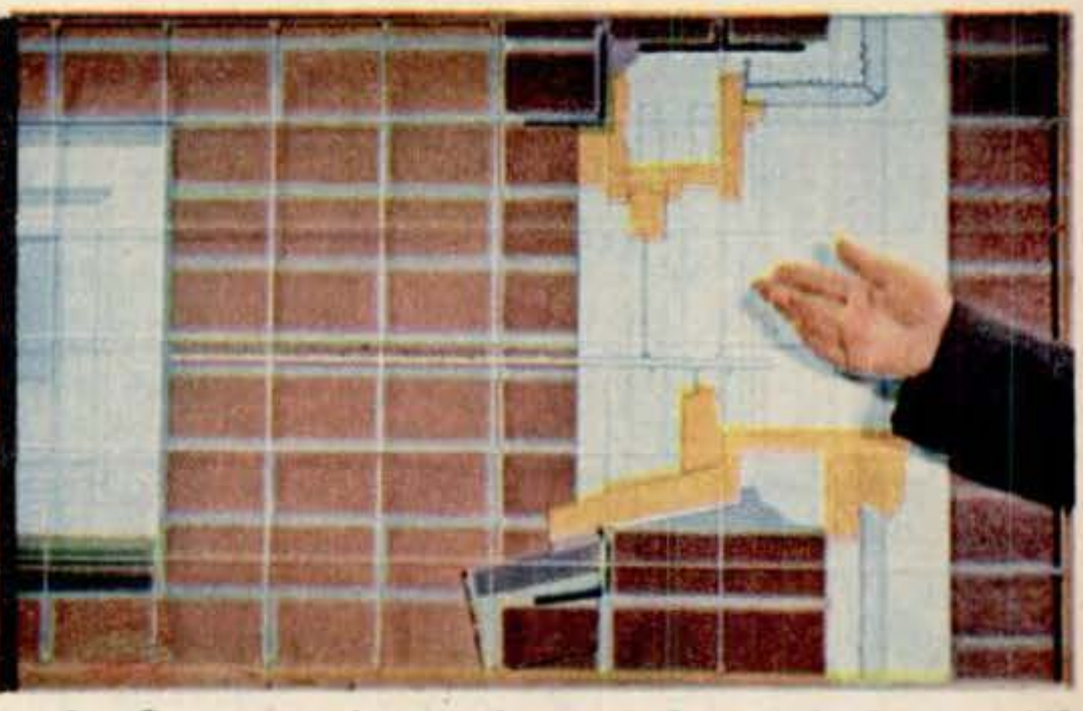
5. The module co-ordinates *all* house parts on a three-dimensional, four-inch grid. See how bricks fit into the pattern.



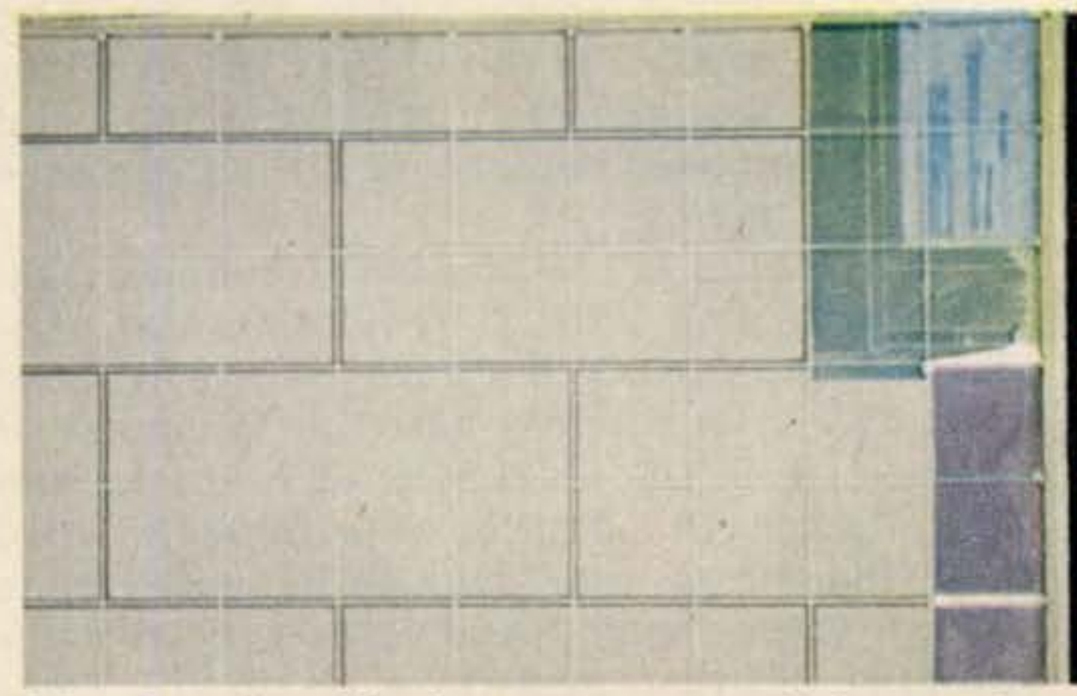
6. All modular measurements are from center of joints, not unit ends. That's why this three-module brick is only 11½ inches long.



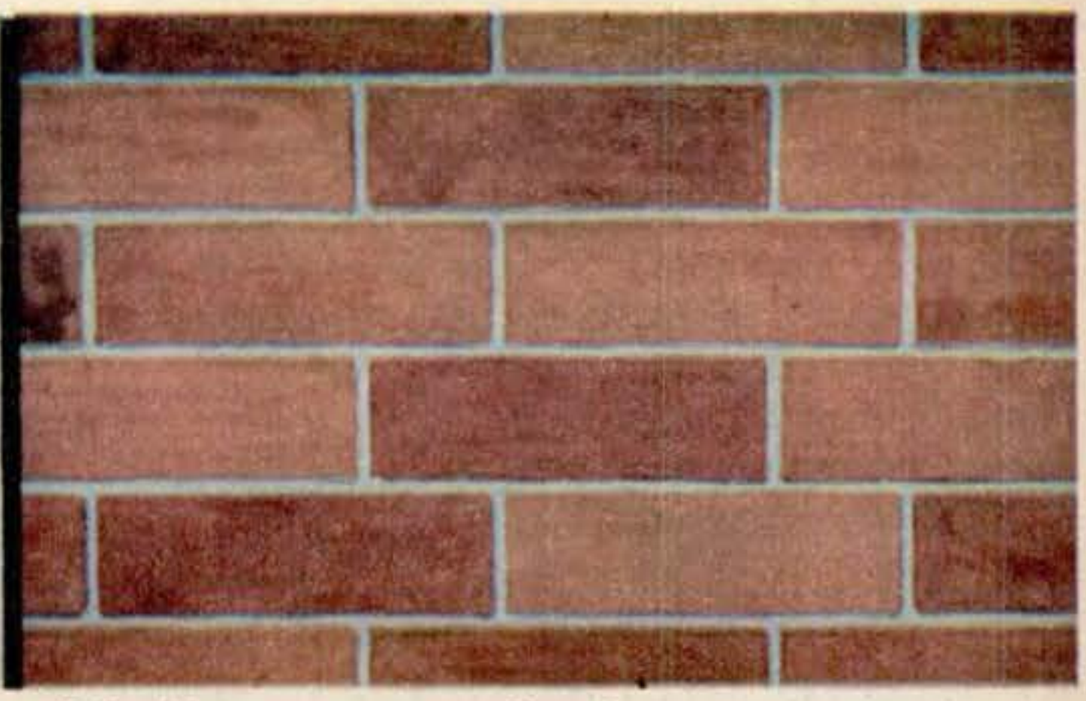
8. Four-inch grid shows the difference. Modular brick (left) has joint every two modules; ordinary brick (right) is just off.



9. Cross-section of modular window with modular brick, behind grid, shows how two can be used together with minimum cutting.



11. Concrete blocks are a natural for modularization. These are four modules by two. Note the fit against steel window at right.



12. Experts urge adoption of a 4- by 4- by 12-inch brick as most economical — the largest size that can be laid with one hand.

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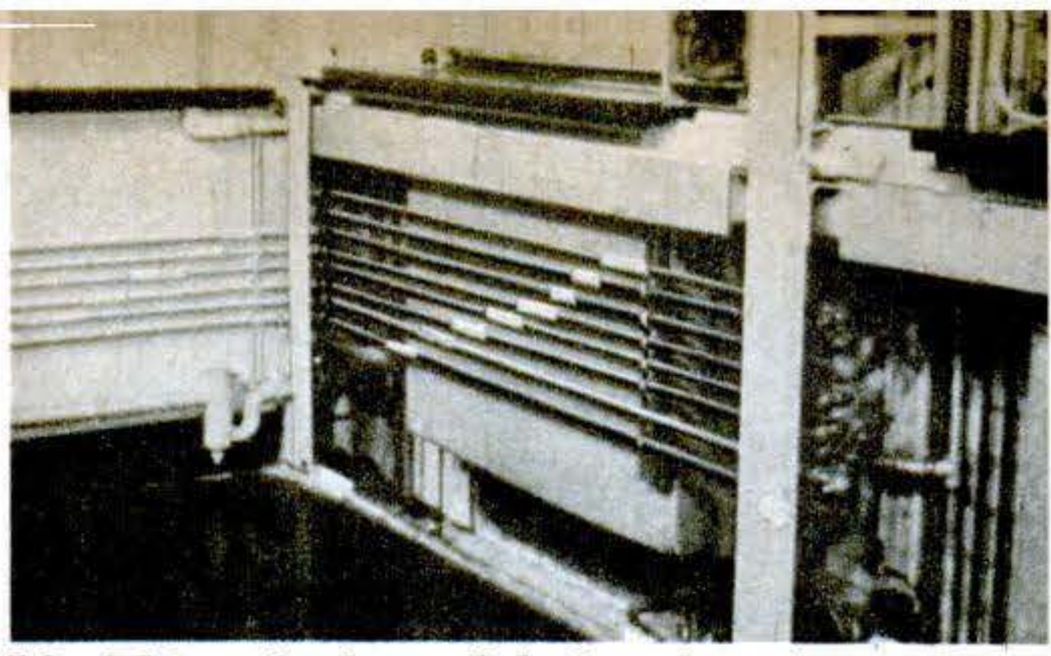
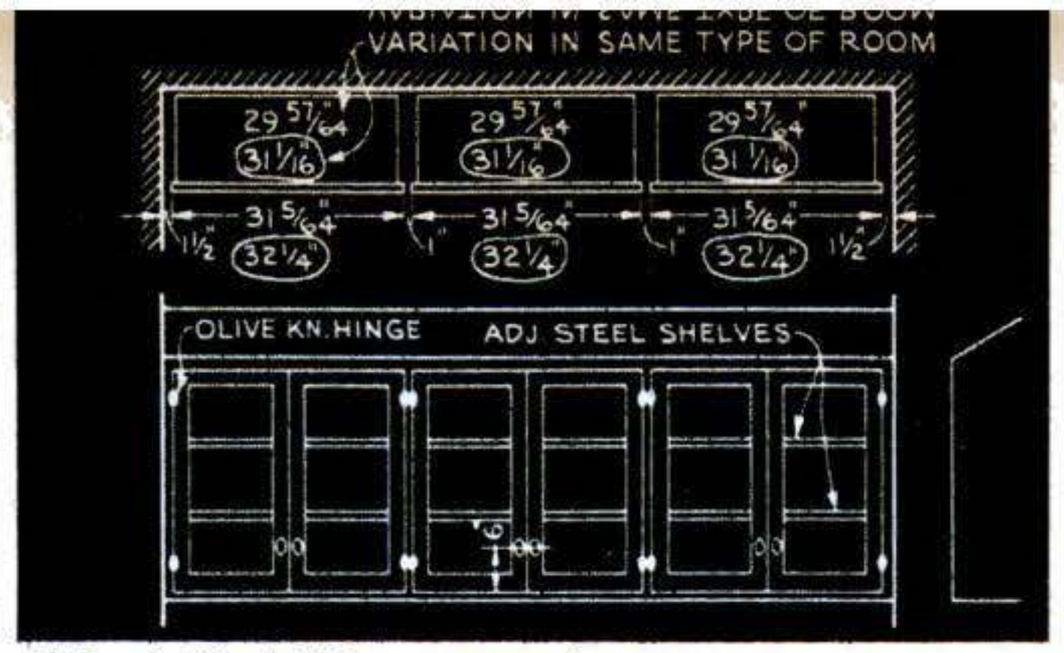
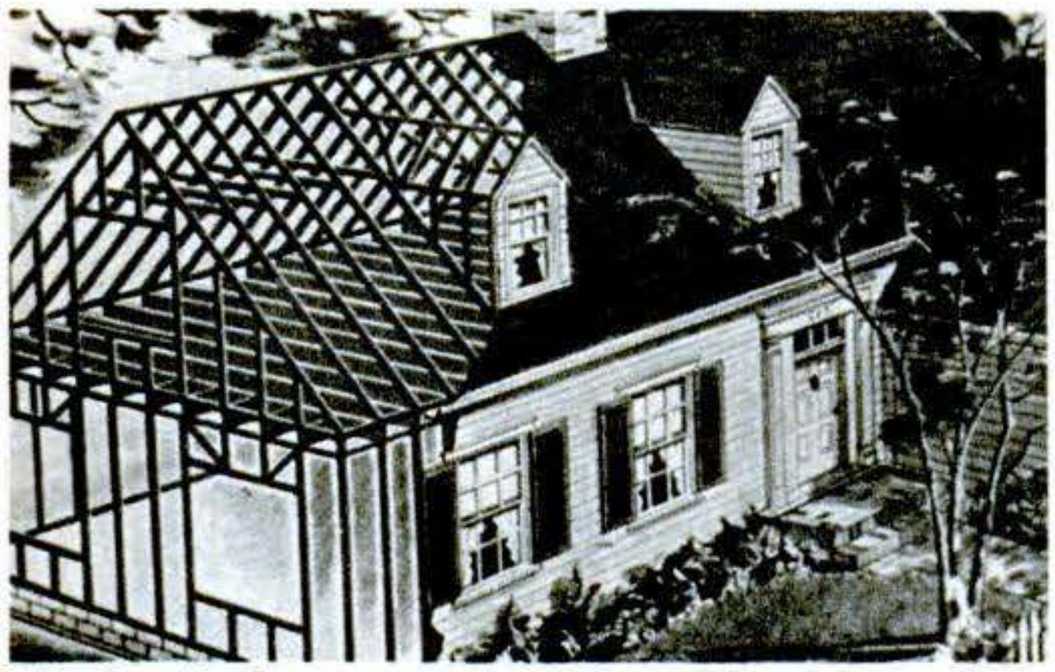


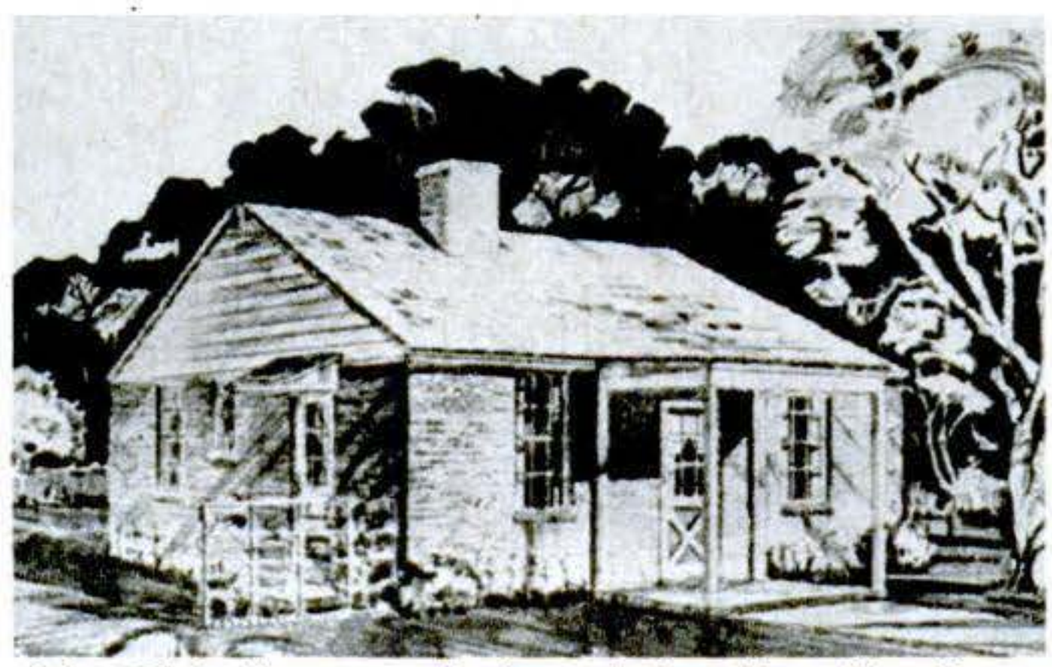
13. This telephone lab interior shows how co-ordination permits easy fitting of equipment into six-foot planning units.



14. A horrible example: Shop drawing shows cabinets vary slightly; drawers cost $20.20 each. Standardized, drawers cost $2.90.



15. Steel framing also benefits from the economies of the module. New types have 20- or 24-inch centers—five or six modules.



16. This house, designed by the Southern Brick and Tile Mfrs. Assn., makes full use of modular masonry, doors and windows.

mensions for aesthetic appeal—and all parts must be cut to fit his plans.

That is the traditional way, and it is still the way all too many houses are built. But the old ways are changing, thanks to the module. Not that the module actually changes either the materials of a house, its style, or the way it is built. It simply introduces the architect, the builder and the building-product maker to each other, making a team of these rugged individualists.

The father of this bright idea wasn't in the building business at all. Alfred F. Bemis was a successful New England manufacturer who became interested in housing for students and textile workers. The more he learned, the more he was appalled. As a result, he wrote a history of shelter, set up a foundation to study it, and crowned his efforts with the Bemis module.

As Bemis saw it, two things were needed to make sense out of the building industry. First, there had to be standardized sizes. This would save money by allowing mass production of a few types, shrinking costly inventories all along the line.

But standardization alone wasn't enough. If bricks came in one set of standard sizes and window frames in another, the bricks would still have to be cut to fit. And even if brick and frame sizes were related, it wouldn't do any good if the architect spaced the windows by whim. There had to be co-ordination of everything that went into the house—including the plan.

Bemis found the double answer in a common unit of measurement. Standardization on multiples of this unit would cut the number of sizes. Use by all manufacturers would make parts fit together. Use by architects would enable all to take advantage of these savings.

Bemis called his unit a "module." Others had suggested it but never agreed on a size. The larger the module, the fewer sizes of each product are needed, and the more the manufacturer saves. But the smaller the module, the easier it is to vary design. Bemis studied the size of every part of a wood-frame house, the common American type. He found that the greatest common divisor—the largest dimension most often used, singly or in multiples—was four inches.

Four inches is the nominal thickness of a structural wall with 2 by 4 stud, and one-fourth the usual distance between stud centers. It is roughly half the thickness of a floor; it is the thickness of a brick, and half its length. It works with both wood and masonry: most wasteful cuts come where these meet. And it is a good compromise between mass production and flexibility: big enough to limit sizes sharply, yet small enough for flexible planning.

Using the module, an architect plans most

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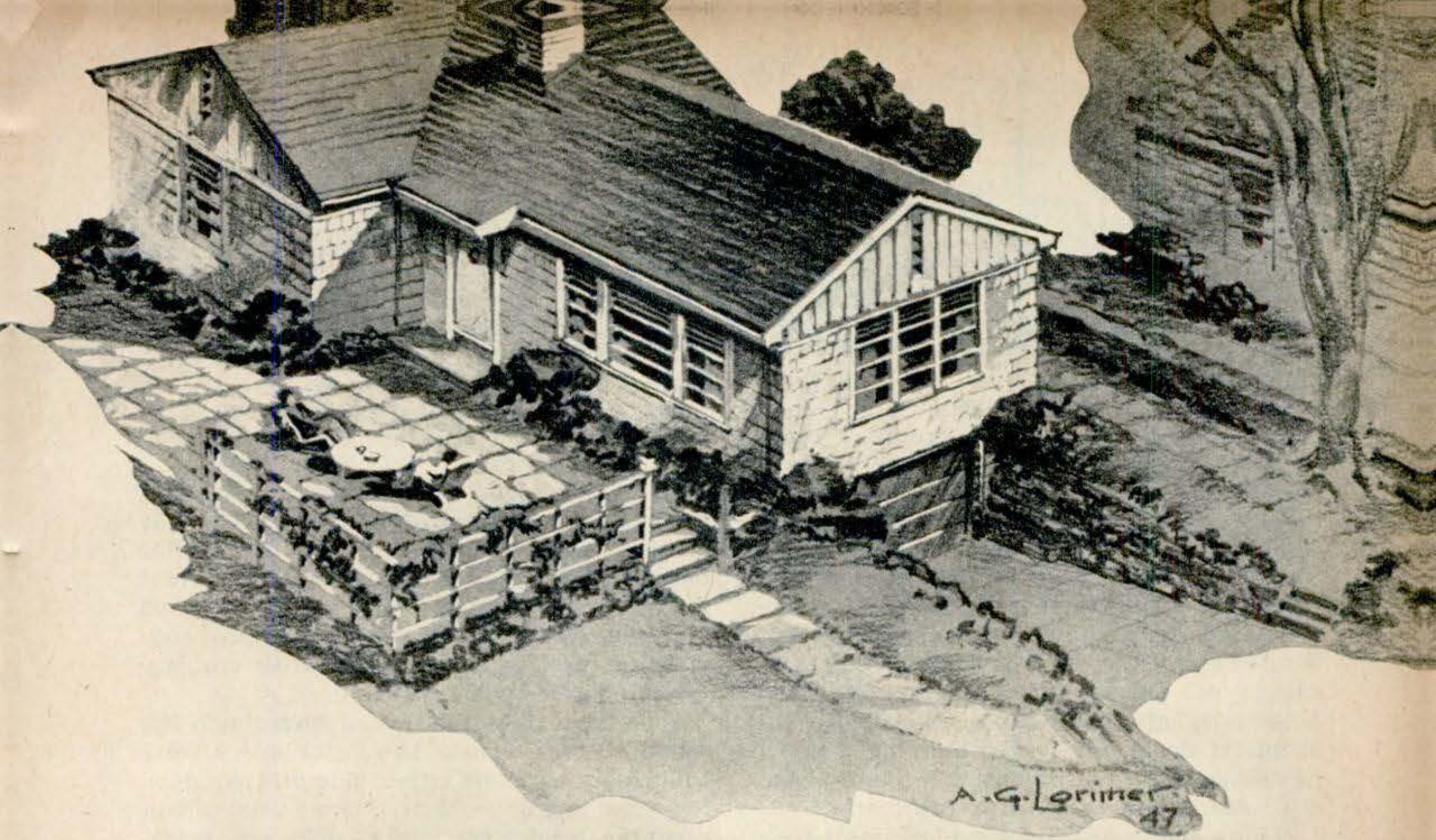

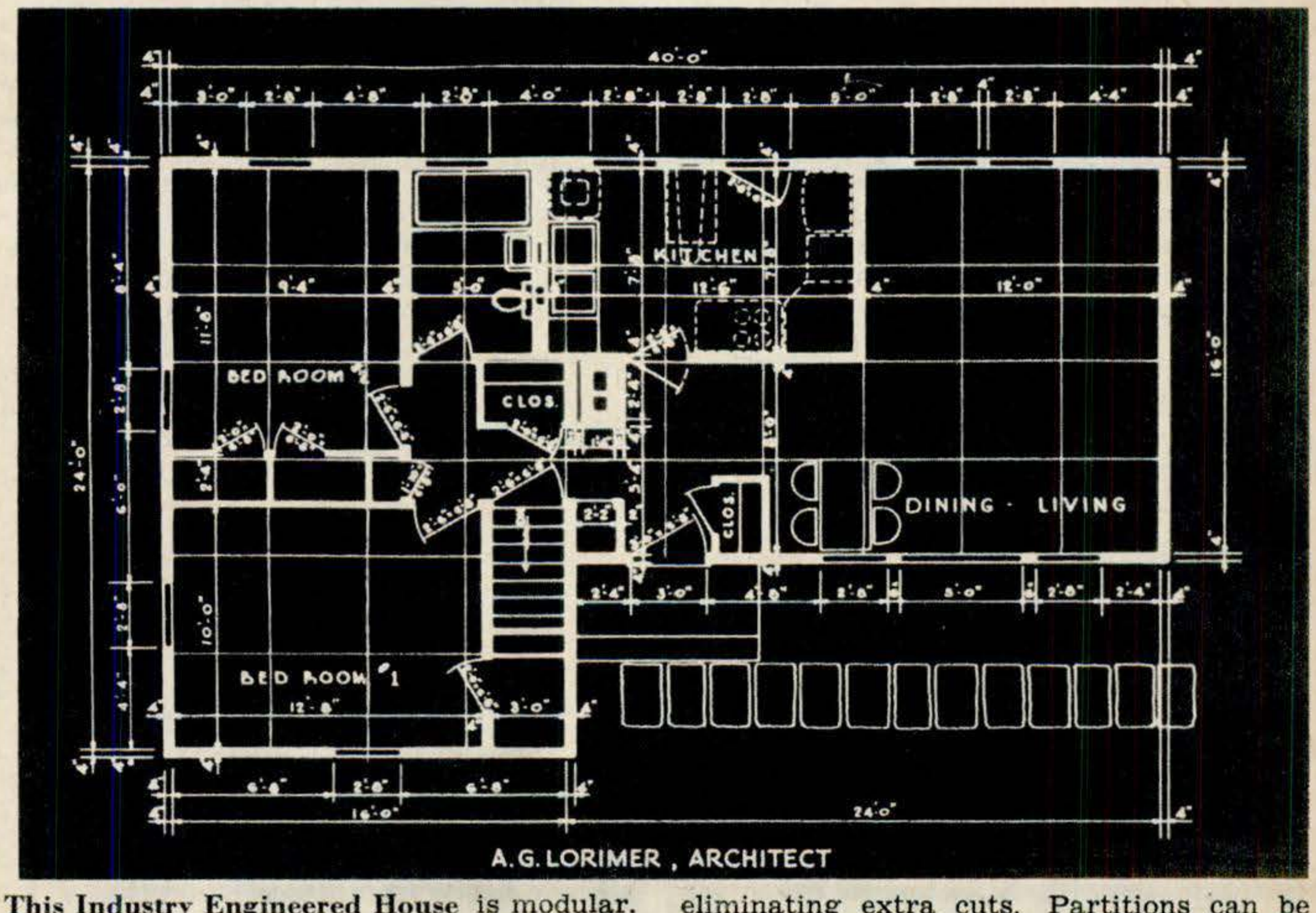

A. G. LORIMER, ARCHITECT

This Industry Engineered House is modular. Test units will be built at the University of Illinois, where thorough studies will be made on best assembly methods. Note how almost all of the building's major dimensions satisfy the four-inch-multiple rule. The two 16-foot sections of this two-bedroom, one-story model permit the use of stock 16-foot floor joists without cutting or intermediate support. Partitions carry no load, so floors and ceilings can be unbroken, eliminating extra cuts. Partitions can be built as unit, swung up and wedged into place. Bathroom and kitchen are put back to back to cut plumbing costs. Dirt from cellar-garage excavations will be used to raise grade around house so only 4½-foot hole is needed. Other modular houses range up to two-story, four-bedroom types, including a glass-walled sun house. Designs are sponsored by National Retail Lumber Dealers Assn. and the Producers' Council.

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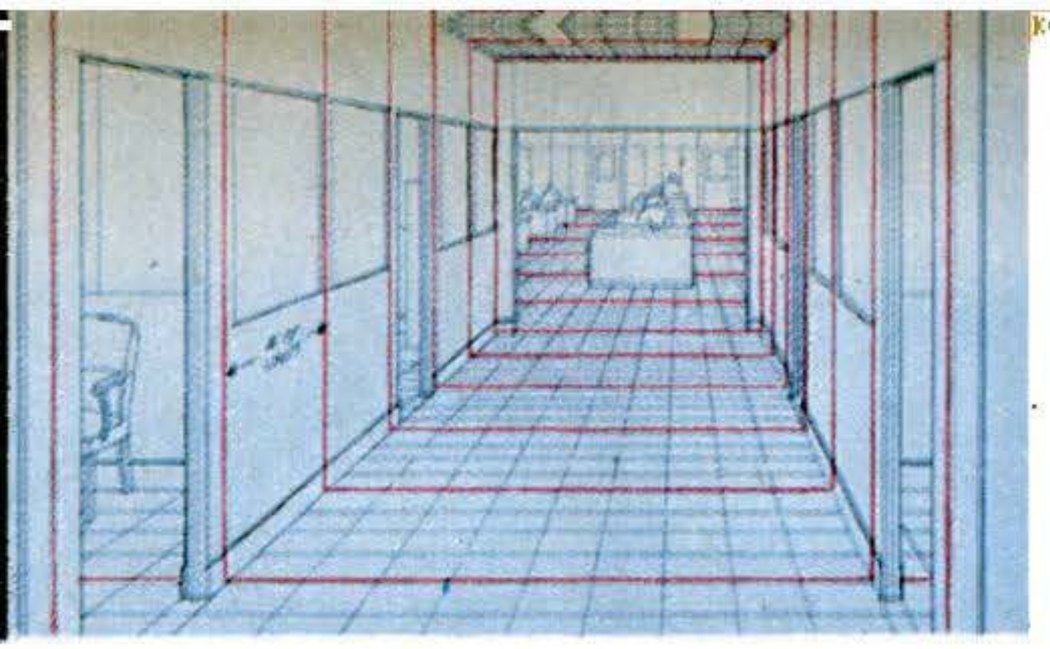
More and more products are being designed in modular multiples. The office unit shown above uses a whole group of them.



Heavy lines mark four-foot (12-module) units. Lighting troughs, ceiling tiles, partition panels, floor tiles are all co-ordinated.

dimensions in multiples of four inches. Then the center of most joints will fall on a modular line, bricks come out even around doors and windows, sheathing needs a minimum of trim, few tiles need be cut. Workers at the site become what they should be: assemblers, not manufacturers. Materials, labor and time are saved. The architect designs a better building because he thinks out details more thoroughly. And the module is a boon to prefabricators.

Bemis died when his big idea was barely under way. Today, architects, building-product manufacturers and the American Standards Association have united to urge general adoption of the Bemis module. Already a wide range of products—glass bricks, most lighting fixtures, tiles, many clay bricks—come in modular sizes. Both wood and steel windows are modularized. Plumbing and heating products have still to fall in line, but a house shell can be built entirely from modular products.

All future New York City building designs, other than schools, will be modular—thanks largely to A. G. Lorimer, a module enthusiast until lately chief architect of the city's Public Works Department. Now the Veterans Administration is urging modular designs for its hospital program. Next step is an international module. The United Nations Standards Committee is now considering proposals—mostly for 10 cm., interchangeable with four inches.

It is hard to estimate just how much the module saves. Once two bricklayers were told to lay walls on either side of a window, for a housing exhibit. One was given modular brick; the other, ordinary brick. Checking later, officials found the modular bricklayer up to the lintel, while the other was fuming along on a lower course, laboriously cutting a brick at the end of each tier to make it fit against the window frame.

The module saves money for the manufacturers, the builder, and you, the ultimate consumer. But workers like it too. A Baltimore contractor hired bricklayers from Oklahoma, where the module is widely used. In a few days they had a complaint:

"See here," they said, "if you'd just get us some of them modular bricks we could really do a job for you!" He did, and they did. With the module, so can you. END

The module's savings are especially great in large buildings, such as Fresno's City Hall.

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Cuts Steel Like Butter. That's the way this oxygen cutting machine slices locomotive parts out of steel plate. It automatically turns out uniform parts up to eight inches thick, the cutting torch following a master template of the required size and shape. The machine is used at General Electric's locomotive shop at Erie, Pa.

Stinson Voyager Carries Four. This personal plane flies at 125 m.p.h., has a 165-hp. Franklin opposed-cylinder engine. In another version, the Station Wagon, the two rear seats lift out to provide 24 cubic feet of cargo space. Both take off in 590 feet with 2,230-lb. gross load.

She Stoops to Conquer. This 500-m.p.h. Navy fighter has been taught to kneel—but only so as many as possible can be packed into an aircraft carrier. Pumping a hydraulic mechanism lowers the nose of the North American XFJ-1 onto a self-contained dolly; the nose gear retracts, and the plane can be pushed into place.

Radio Goes on Tour. Boulder Dam—in the background—is just one of the out-of-the-way places where GE's new portable, rechargeable radio was tested. It was more fun than work for designer A. David Middleton, who took the set on a 15,000-mile test tour of the United States and Canada. Middleton reports that the radio brought in programs at the most remote points. The set was recharged on the auto battery.

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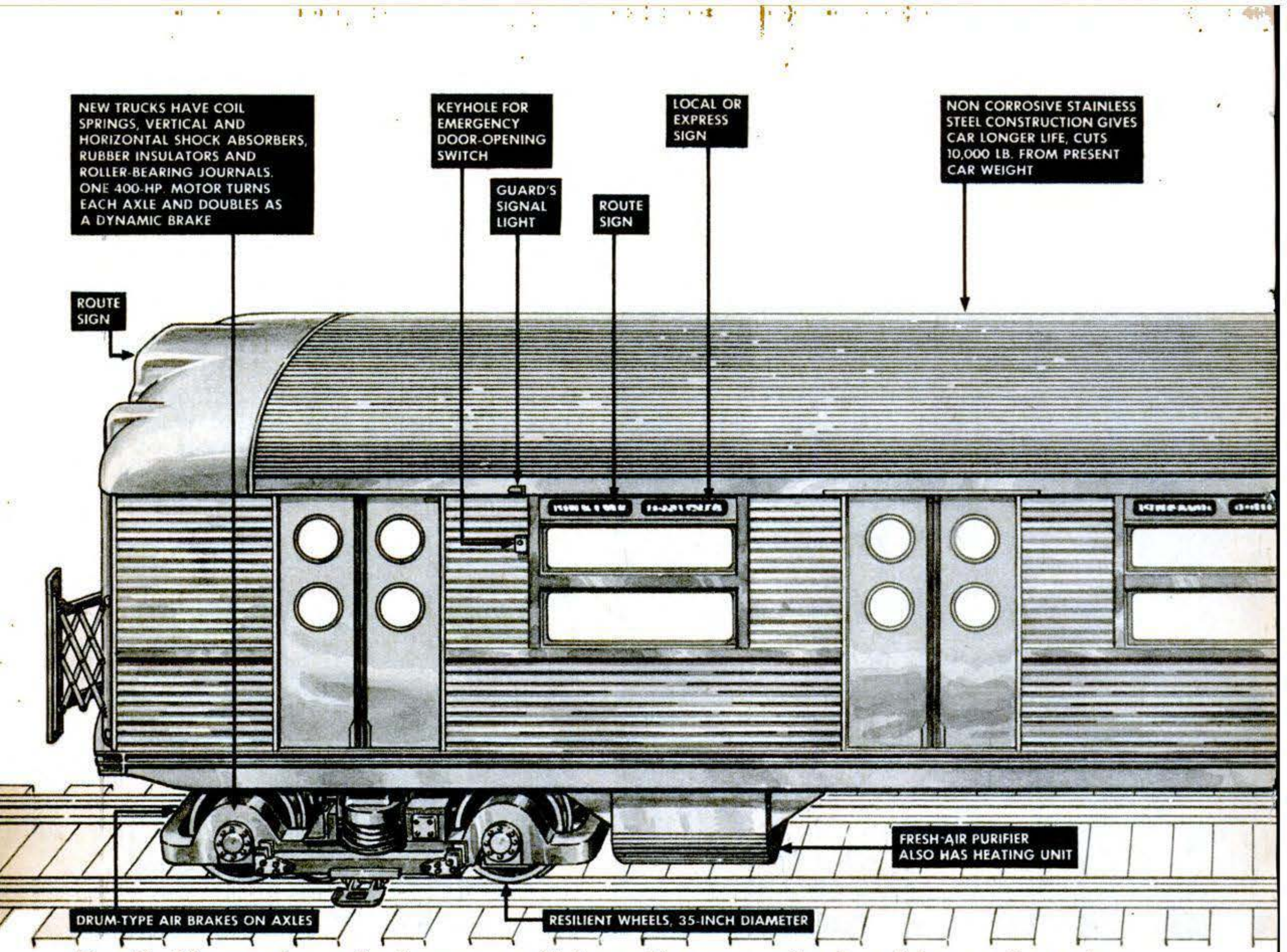

New York's experimental subway cars will have shiny, streamlined, stainless steel exteriors.

Subways to Pack 'Em In

TRANSPORTATION'S Sad Sack, the subway rider, is going to get a break at last. The New York subway system has ordered a 10-car experimental train, which hopeful subwayfarers have already dubbed the "Super-Dooper." It will arrive next year to give them a cleaner, quieter, smoother, brighter and altogether cheerier ride.

The patron will spot the new train the moment it pulls into the station, its stainless steel sides gleaming. He will find the door easier to push through—it is four inches wider—in rush-hour jams. Inside, he'll be greeted by a bright two-tone color scheme instead of grimy green. When he unfolds his paper he will be surprised by three times the usual amount of light; fluorescent lamps will throw 17 foot-candles at the reading level. What's more, there will be no annoying blackouts at third-rail gaps; a flywheel will keep the motor generator spinning 10 seconds without current.

As the train pulls out, the passenger will find it picks up speed a little faster and a lot more smoothly. Better motor controls will help smooth starts. Coil springs and vertical and horizontal shock absorbers will take out sway and bumps. A lot of noise will be gone, partly because of the individual-truck suspension of the four 100-hp. motors, one for each axle. The gears that transmit power will be constantly bathed in noise-absorbing oil, the wheels will be resilient and rubber-insulated, and the usual clattering brake-mechanism rigging will be eliminated.

The rider will get plenty of fresh, clean air en route. A roof grille will pick up 3,000 cubic feet a minute from outside; the heavy dust particles will be whirled out by a centrifuge, the light ones pulled out by a pre-

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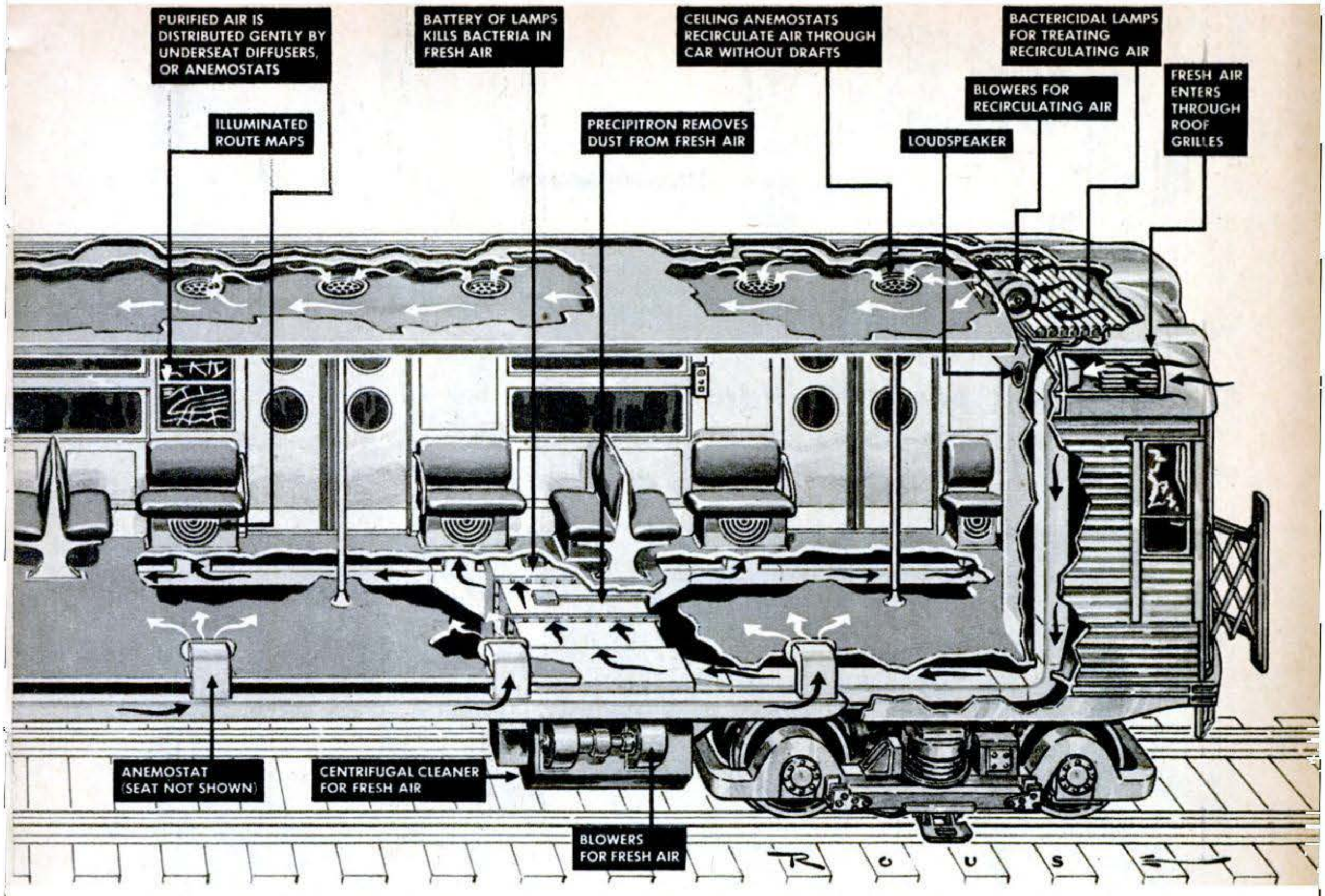

Clean, fresh air, bright lights, and a smooth ride will help eliminate those subway blues.

Comfortably

cipitron. In winter the fresh air will be heated. Twice as much air will be recirculated by blowers. With outlets carefully planned to eliminate drafts, this double circulation system will move 100 feet of air past the rider every minute. In hot weather the recirculation will automatically step up. And passengers won't have to worry about catching subway colds or flu germs because both air streams will be sterilized by ultraviolet lamps that kill 95 to 100 percent of airborne bacteria.

Curiously, the improved braking system will help keep the cars cleaner. With present brakes, eight tons of steel dust are ground off the shoes of New York City's thousands of cars every day and deposited on the tracks, cars and passengers. The new cars will have dynamic brakes (the electric motors run in reverse), and the friction brakes won't take over until the speed of the train has been brought down to 10 m.p.h.

If the subway rider gets lost along the way, a specially illuminated subway map in each car will help him find his route. And he'll have no trouble finding the names of the stations—each one will be announced over a loudspeaker.

The train will be built by Budd with two truck designs for comparative tests. The cars with one type will cost $109,000 each; the others, $116,000. Both are a good deal more expensive than present types, but their stainless steel and aluminum construction, which saves 10,000 pounds per car, will help make the difference up in lower operating costs. Reduced maintenance of the bright-metal exteriors will also mean a saving.

Interiors of the new cars will follow present designs pretty closely, but there will still be plenty of room for standees. END

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Wings Fold for Storage

STORAGE of the Convair L-13 (above) is simplified by its folding wings and tail. First all-metal liaison plane, it carries six persons and can be towed in flight. Its uses will include supply-dropping, ambulance work, photography and communication.

2-0-2 in Production

SPEED, comfort and economy are the combined aim of the 40-passenger, twin-engine Martin 2-0-2 (above). Now in production, it cruises at 280 m.p.h. and offers such features as built-in loading steps and special racks for passenger-handled luggage.

Pusher Gets Jet Boost

A PAIR of Westinghouse 19-XB jets, slung under the wings, join with counter-rotating propellers in the tail to give the Douglas Mixmaster (below) a speed of 500 m.p.h. Used for alternate or emergency power, jets each deliver a 1,600-lb. thrust.

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Who's Who Over South America

THE growing airways of our neighbors to the south, like other air and sea lines the world over, bear colorful insignia reflecting proud traditions. Here are some examples, ranging from stylized modern wings to two symbols—the condor and the Southern Cross—that were familiar sights in South American skies long before man ever decided to take to the air.

Lloyd Aero Boliviano is among the air lines that portray the giant Andean condor, which is also the national bird of Bolivia.

Aerovias Brasil is part of Transporte Aereos Centro Americanos, an organization that operates over Central and South America.

Flota Aerea Mercante Argentina's emblem has wings and a map of the Atlantic Ocean, symbolizing its operation on overseas routes.

Cruzeiro do Sul, of Brazil, depicts a seagull flying beneath the Southern Cross (from the Brazilian flag), for which the line is named.

Compania de Aviacion "Faucett," of Peru, has a stylized wing and an inset showing the condor perched upon a map of the country.

Panair do Brasil, an international line, repeats the globe and Southern Cross of Brazil, uses the wing and color of parent company.

Aerovias Nacionales de Colombia also relies upon the condor. Its insigne shows the bird hovering over a circled map of Colombia.

Linea Aeropostal Venezolana's graceful bird carries the line's monogram against a bright background of the national colors.

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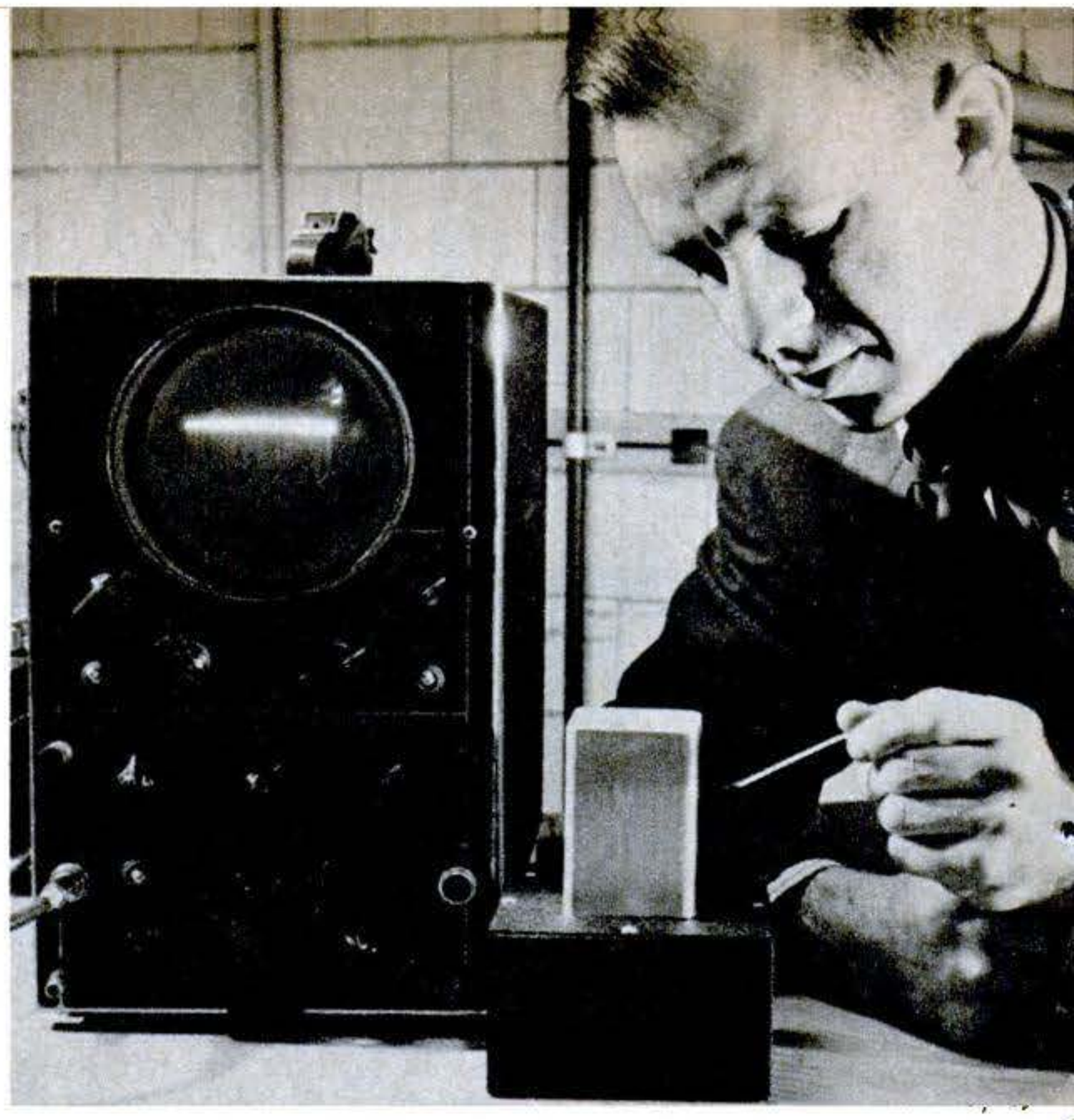
Radiation Meter Faster Than Geiger Counter

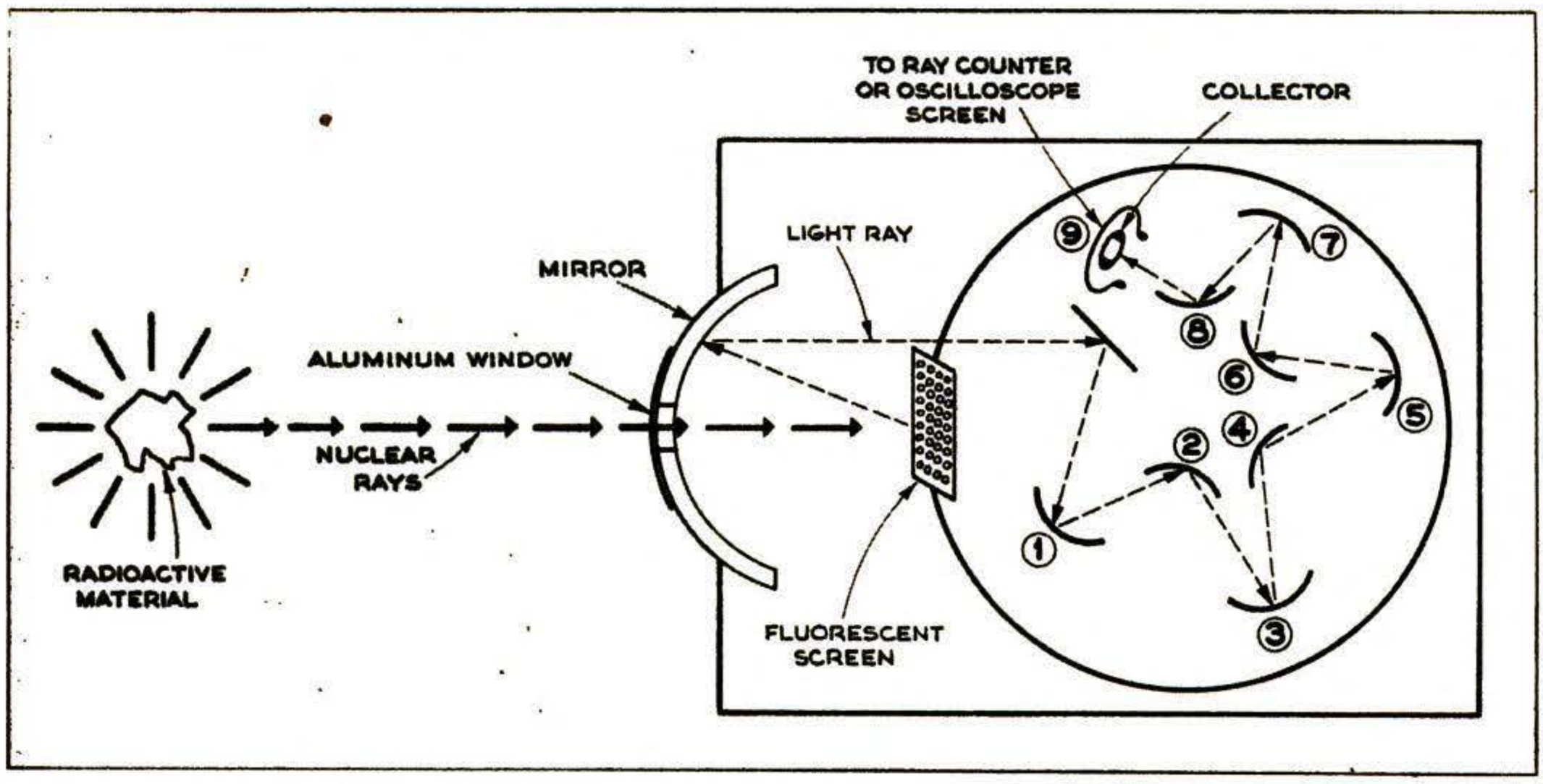
A METER that counts fragments from exploding atoms 50 times as fast as a Geiger counter has been developed at the Westinghouse Research Laboratories. Able to tally 100,000 particles a second, the new instrument can be used for jobs that make the slower Geiger tube "go crazy"—such as measuring how fast some nuclear materials lose their radioactivity.

Geiger counters contain a gas that atomic particles will ionize, or break up into charged gas atoms that conduct electricity. This ionization permits a surge of electricity to flow through the tube and trip a counter. So long as the particles arrive at a reasonable speed—less than 2,000 per second—the Geiger tube counts each one. But above that rate the gas cannot ionize and de-ionize fast enough to keep up with the incoming particles and the tube loses count, giving a steady current instead of individual surges.

The new device, invented by Drs. Fitz-Hugh B. Marshall and John W. Coltman, uses a different principle providing clear counts up to 100,000 per second. As shown in the drawing below, it has a fluorescent screen, a spherical mirror, and the recently developed multiplier photoelectric cell, connected to amplifying and counting circuits. Atomic particles enter the detector via a thin aluminum window that covers a slit in the center of the mirror. This aluminum window keeps out light, which the detector cannot distinguish from atomic particles, but lets the particles through. The particles hit the fluorescent screen, making it give off a light ray, which is reflected by the mirror to the light-sensitive plate in the phototube. The light ray knocks loose a swarm of electrons that travels inside the tube from one multiplying plate to another, growing in size each time it bounces off a plate. When the swarm finally reaches the collector, the number of electrons it contains has increased a million times. This electron burst is then amplified to trip a counter or make a flash on an oscilloscope.



Dr. Marshall holds a radioactive wire near the new meter. It counts atomic explosions, which appear as flashes on the oscilloscope.



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Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish. Suggestions cannot be acknowledged or returned.

I'd like to see them make

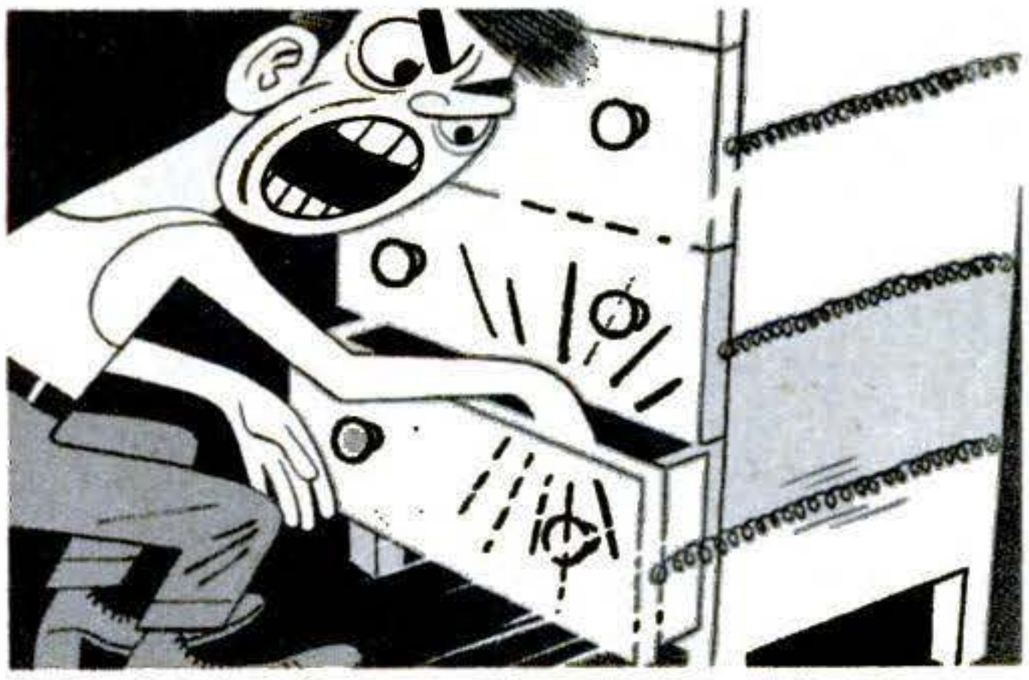
Cartoons by SYD LANDI

Mechanized Newsstands. To speed rush-hour buying of newspapers, Ethel Geller, of Brooklyn, N. Y., wants coin-operated dispensers on street corners and in subways.

Safe-Passing Signs. Placed on the backs of slow-moving trucks, they would warn of approaching cars and prevent accidents, asserts Edgar Peck, of Geneva. O.

See-All Sink Pipe. Clogs in the drain could be spotted before becoming serious if pipes were made of transparent material, declares Jack E. Sun, of Shanghai, China.

Shake-Safe Strainers. Two strainers, clamped together, would simplify the rinsing of foods that require tossing, writes B. W. Sorrow, of Seattle, Wash.



Self-Closing Drawers. Spring-fastened bureau drawers that slide shut by themselves would save time and tempers, believes Mrs. H. C. Crouch, of Dallas, Tex.

Nonstop Typewriter. For uninterrupted typing, J. O. Day, of Fort Worth, Tex., suggests long rolls of paper marked in standard page lengths for later cutting.

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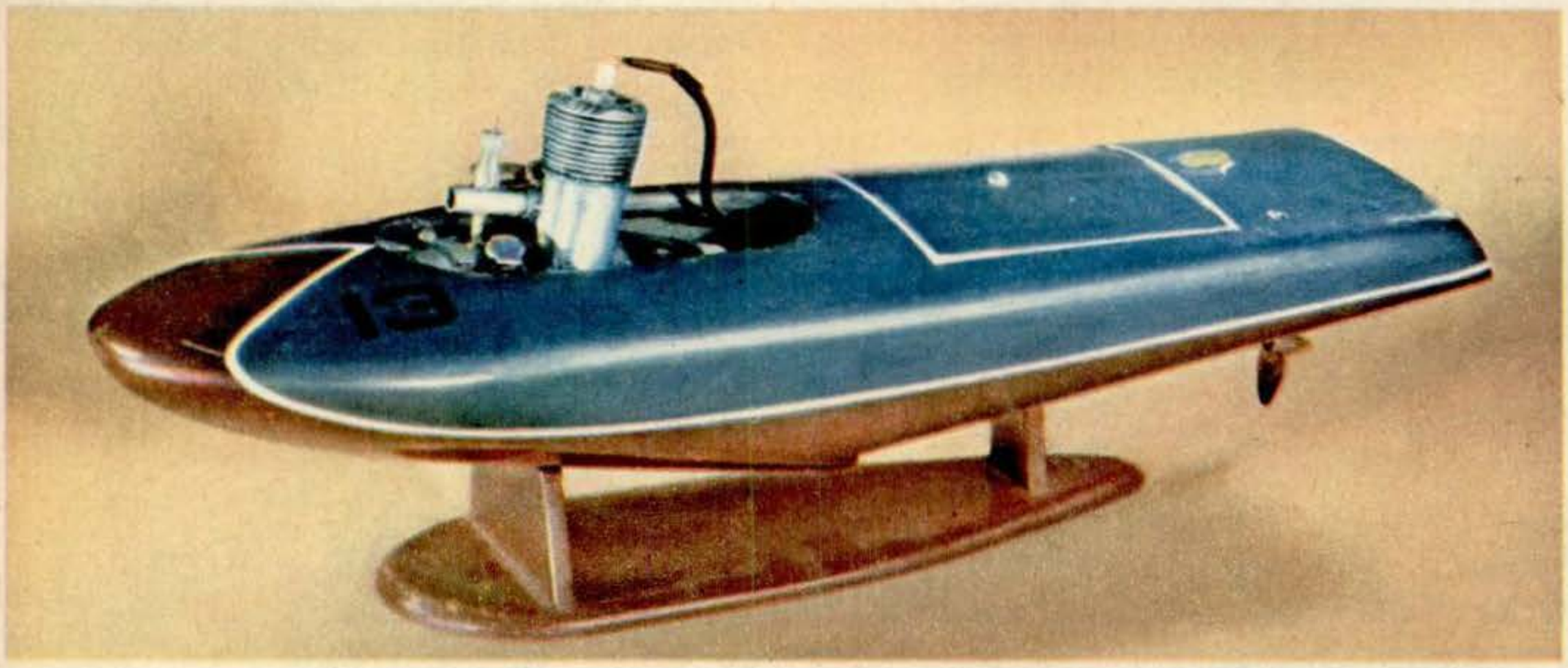
CRAFTWORK

PROJECTS OF THE MONTH

Illuminated Garden. Here's something to whet your tinsnips for. Made of polished copper or brass, a "planter's lamp" adds that touch of living greenery prized by homemakers. It makes an impressive gift, too. You'll find how-to-build plans starting on page 164 of this issue.



Engine Planes Tiny Boat. You don't need to bother with laborious planking methods to build this 16-inch speedboat; its hull is made of easily shaped balsa blocks. A model gas engine powers it at a fast clip in the water. See page 176 for details.

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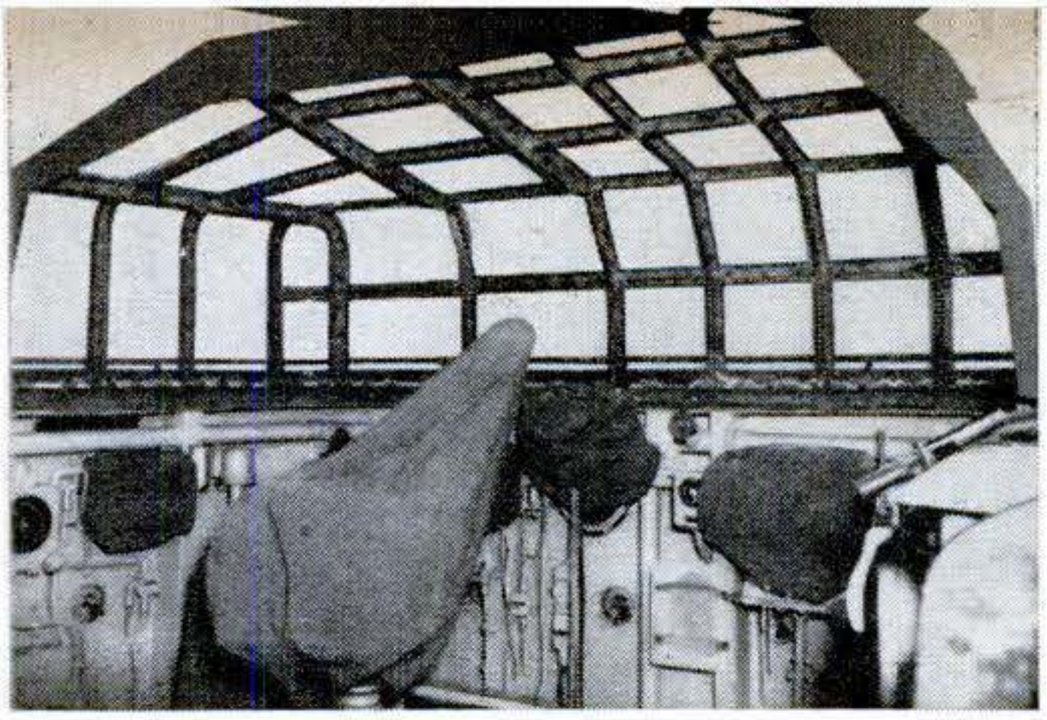
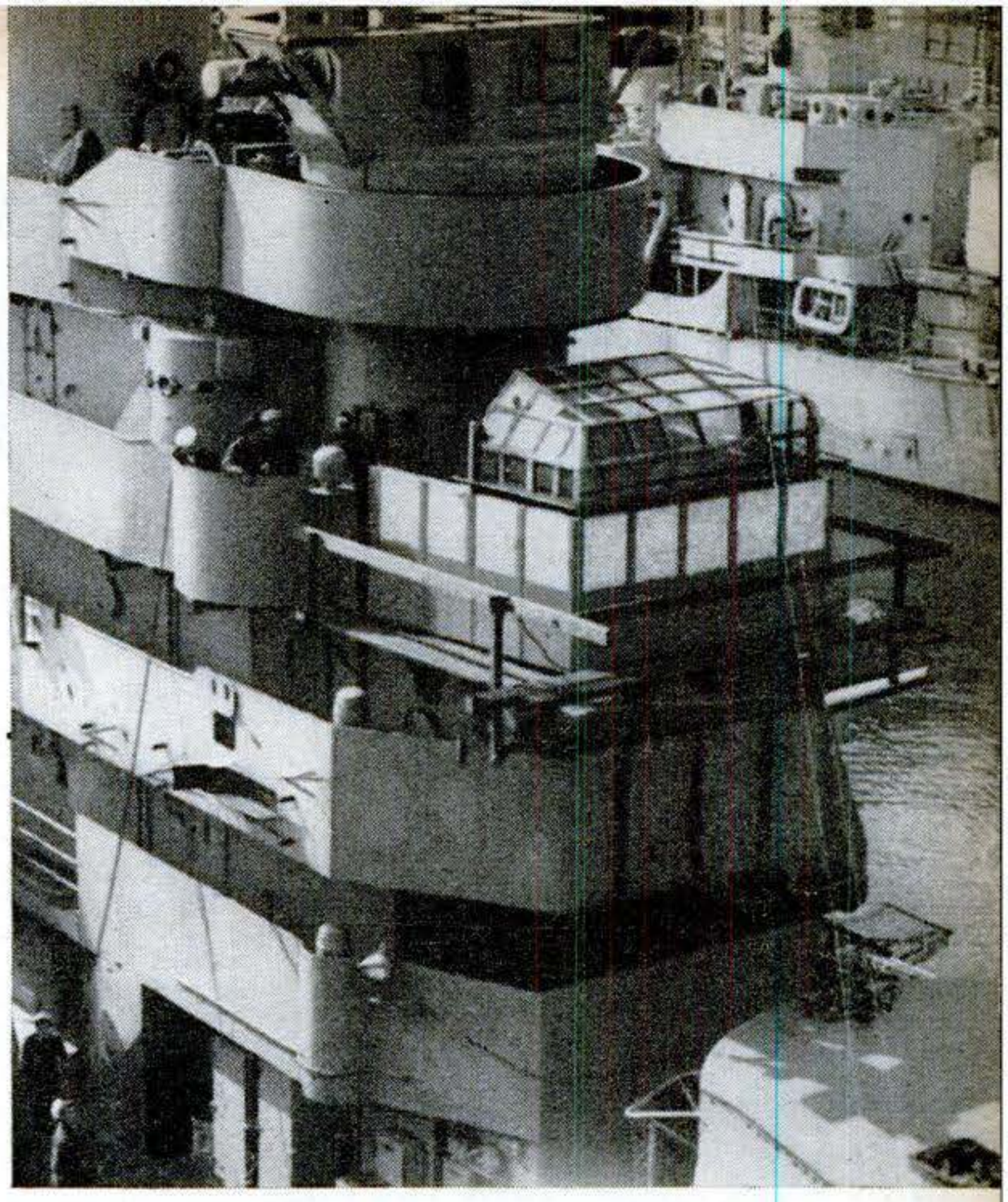




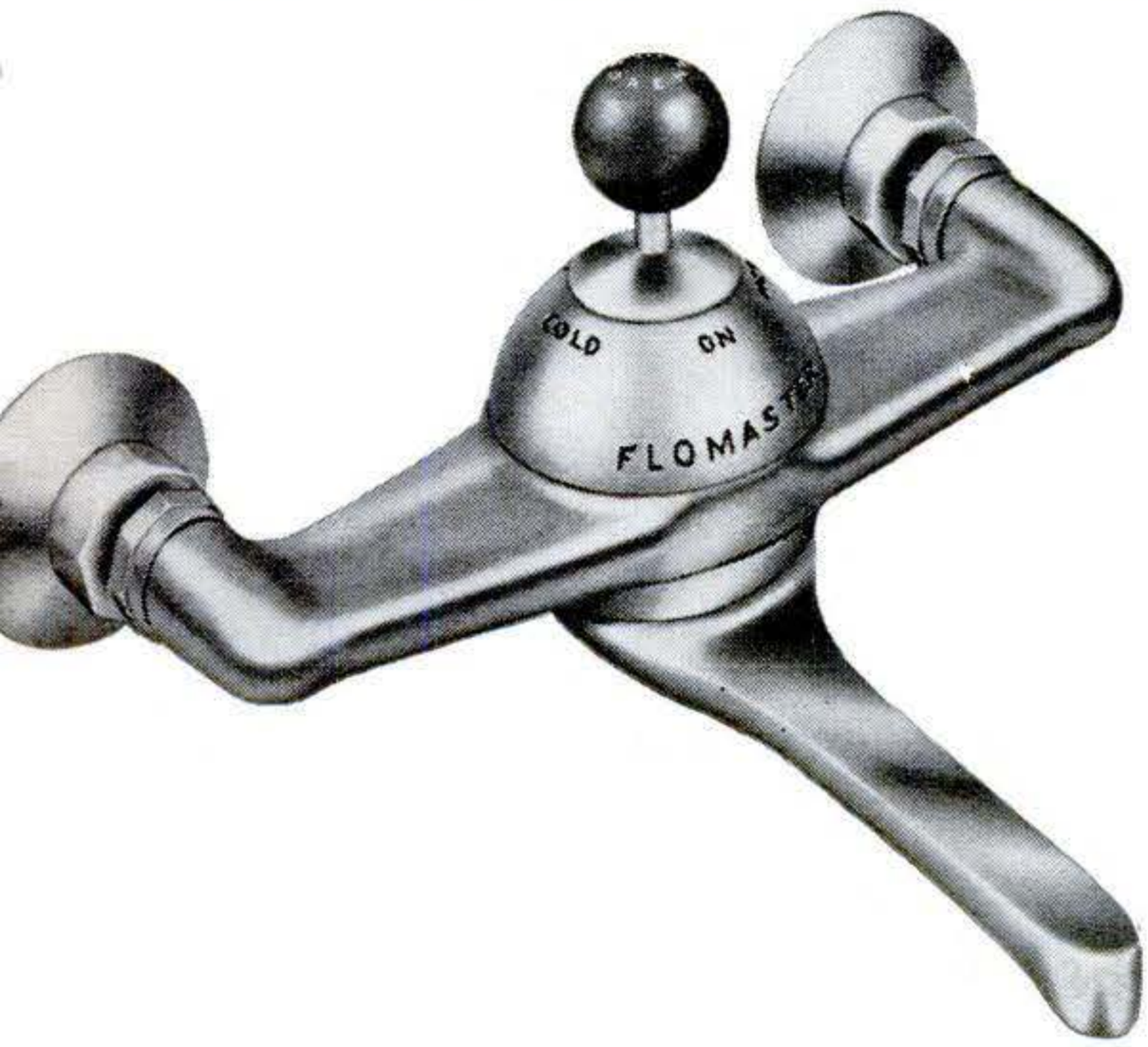
Navy Cruiser Tests Plastic Bridge Shelter

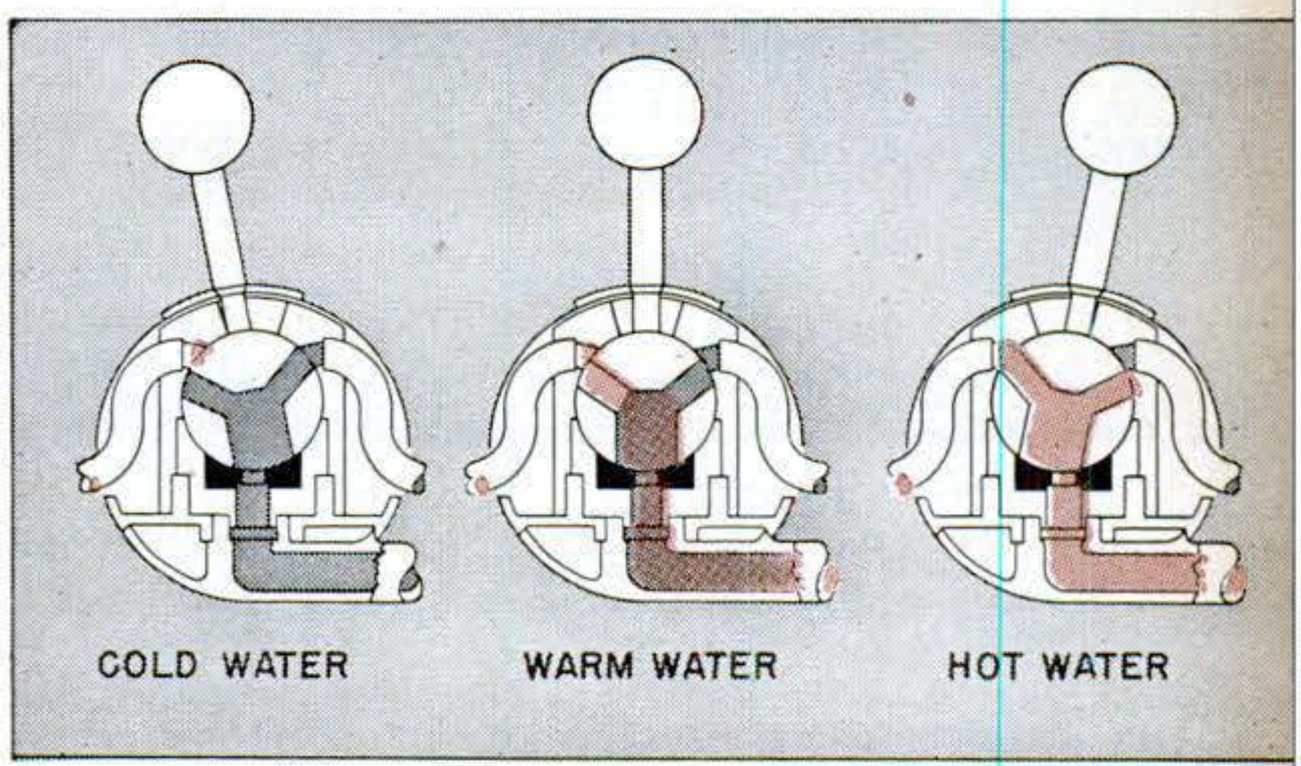
THE almost legendary spectacle of a ship's open bridge, its handful of hardy watchstanders lashed by wind, rain and spray, may soon be a thing of the past. To shelter exposed personnel on the traditionally open bridge of warships, the Navy is experimenting with a transparent plastic shield designed to be put on the forward section of the bridge and give it front, side and partial overhead protection.

Familiarly known as the "greenhouse," the windowed canopy (at left, above) is formed of panels of clear plastic set in a metal framework. Besides balking the ravages of weather, it is intended to provide protection in combat against gun blasts and fumes. Now undergoing a trial installation on a light cruiser, the *USS Manchester* (at right, above), it was constructed in the Naval Shipyard at Boston in a series of experiments to determine the most effective covering for ultimate fleet-wide application.

Spherical-Valve Faucet Does Two Jobs at Once

THE single handle of this novel kitchen faucet, made by the Flo-Master Corp., works like the control stick of an airplane to provide simultaneous regulation of both temperature and volume. Operating a spherical valve, the knobbed control is moved from side to side to vary the proportion of hot and cold water flowing through the sphere's Y-shaped tubes to the outlet, as diagramed below, at right. When the knob is pushed to the rear, it shuts off the faucet by disconnecting the base of the Y from the spout; pulled forward, it gradually brings the openings of Y and spout together, increasing flow without altering temperature.





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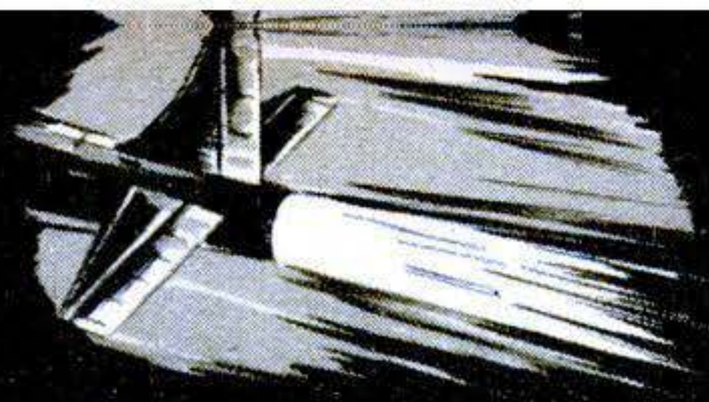
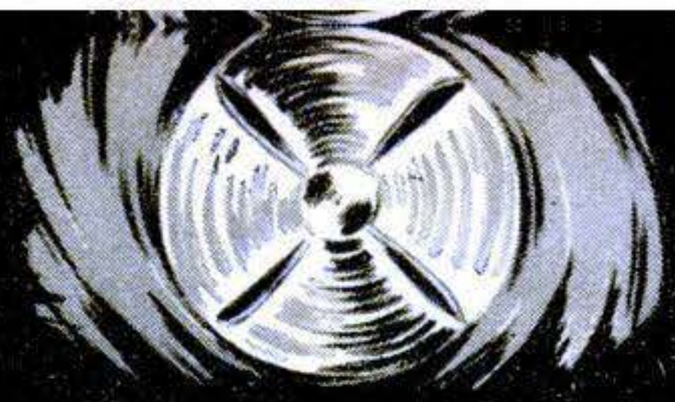
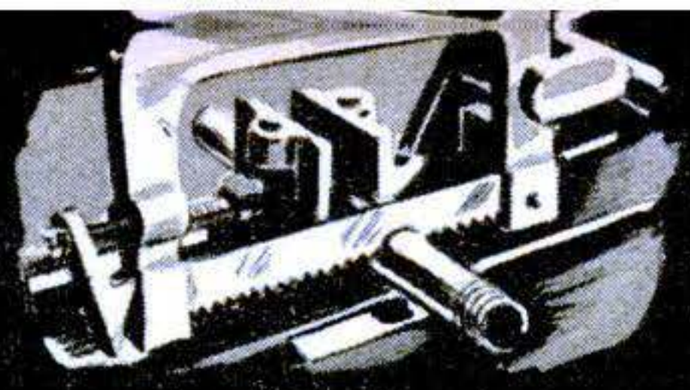


Close to the tailpipe of a jet plane; causes dizziness.



In direct line with a four-bladed propeller 10 feet away.



Power saw operating on metal, going at full speed.

Old-fashioned bus going fast on a bumpy country road.

A riveting gun, as heard from a distance of 35 feet.

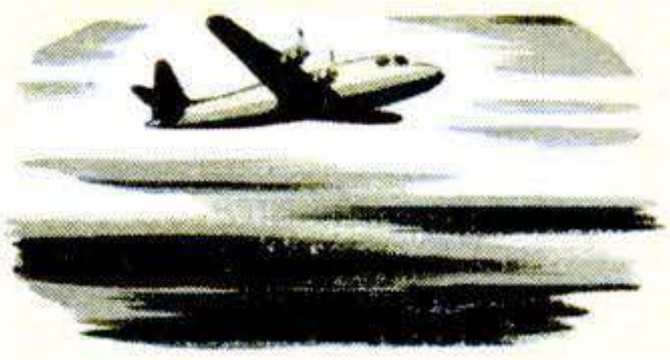
Near-by light plane (65 hp.) during its engine warm-up.

Steamship whistle, as heard from 115 feet away.

An old-style streetcar, as heard from the sidewalk.

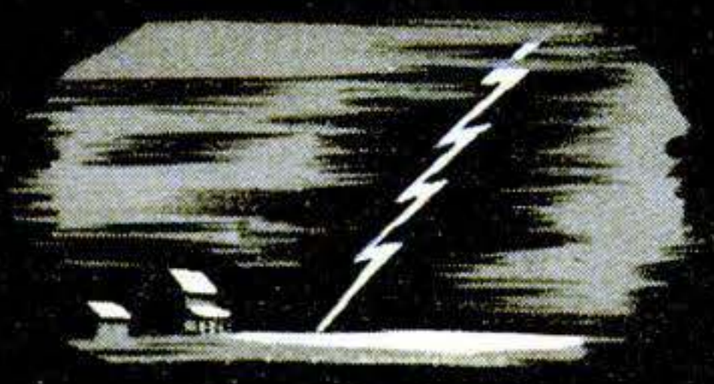
Noisy, but a soundproof cabin makes it comfortable.

Office, six floors above traffic, with windows open.



Four-engine transport plane flying 2,000 feet overhead.

A dog barking can be noisy in a quiet residential area.

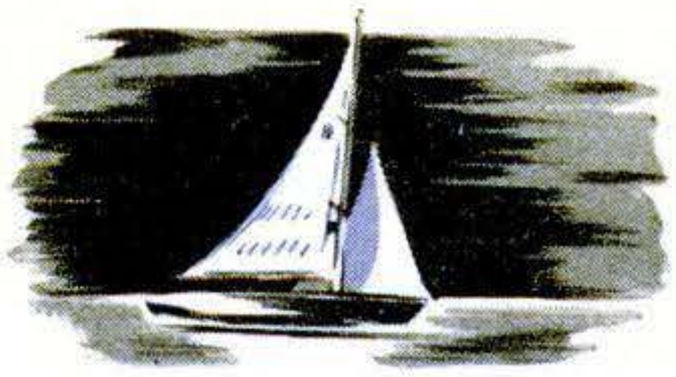


Thunder one to three miles away is not so noisy.

But a man's sneezing in a quiet room can be annoying.

A soundproof Pullman car is easy on ears and nerves.

The reading room of a library is really quiet.



At four m.p.h., even a sailboat makes a noise.

NACA's experimental "quiet" plane shows it can be done.

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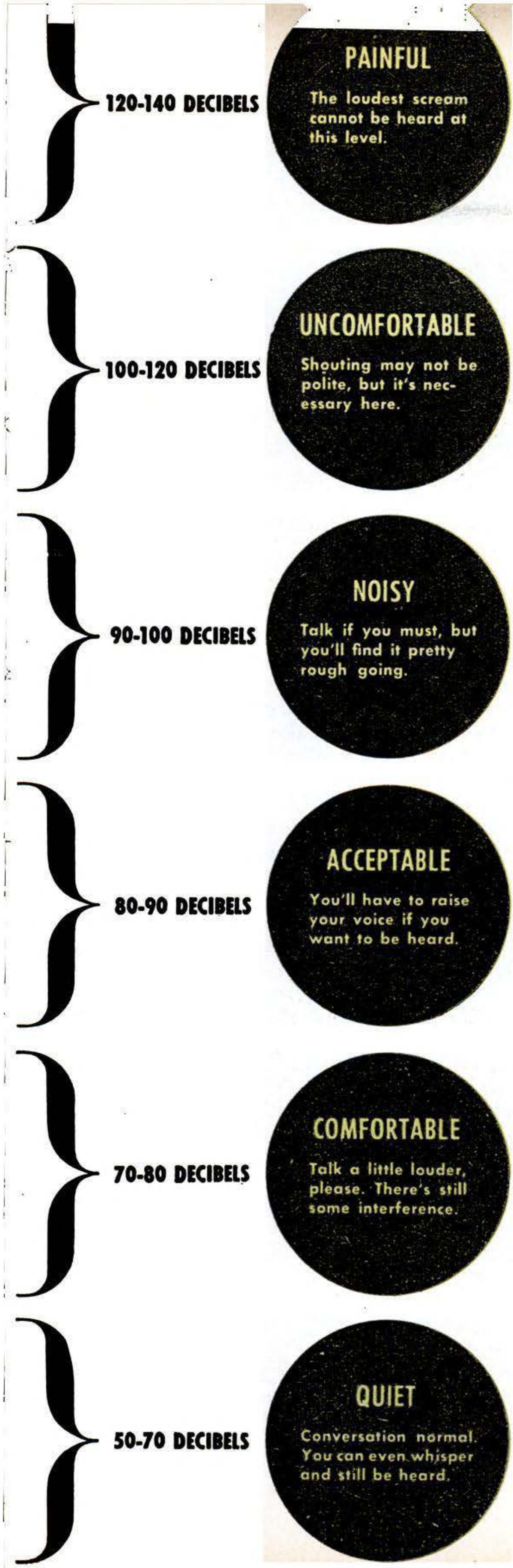

Can We Fly Silently?

NACA's "quiet" plane points the way toward a lot less racket from the air —but how much noise is noisy?

By Herbert Johansen

AS THE test plane rolled to a stop, an acoustical engineer stuck his head out of the cabin door to shout: "We've done it, chief. That new exhaust gadget lopped off another five decibels!"

He jumped down, joined a group of men at the end of the runway and pointed to a graph. "This 100 decibel reading," he explained, "was taken from the rear passenger seat. You remember. . . . ."

"Forget your infernal decibels," broke in the chief. "How did it sound? Was it comfortable?"

"Well, if you mean the over-all noise. . . I guess there wasn't much difference."

"Then try something else. Air-line passengers aren't wired for decibels."

Decibels, a measure of sound intensity, like statistics, can be made to prove almost anything. Acoustical engineers, with tuning forks, electronic analyzers and octave filters, can and will demonstrate that airplanes are not as noisy as you think.

But there is more to sound than decibels, or the energy of the vibration. Also important is frequency, or the rate of vibration of the sound. Both together make up perceptible loudness. The catch is that the human ear cannot tolerate much sound energy at high frequencies, but can tolerate a great deal more at low frequencies.

A high propeller-tip speed, for instance, produces both a high frequency and a high intensity. Cabin soundproofing has helped reduce this sound irritant for air passengers, but that is no comfort to a man in his quiet parlor when a plane flies overhead.

The greatest clamor against airplane noises today comes from the man on the ground who lives near an airport. Annoyed

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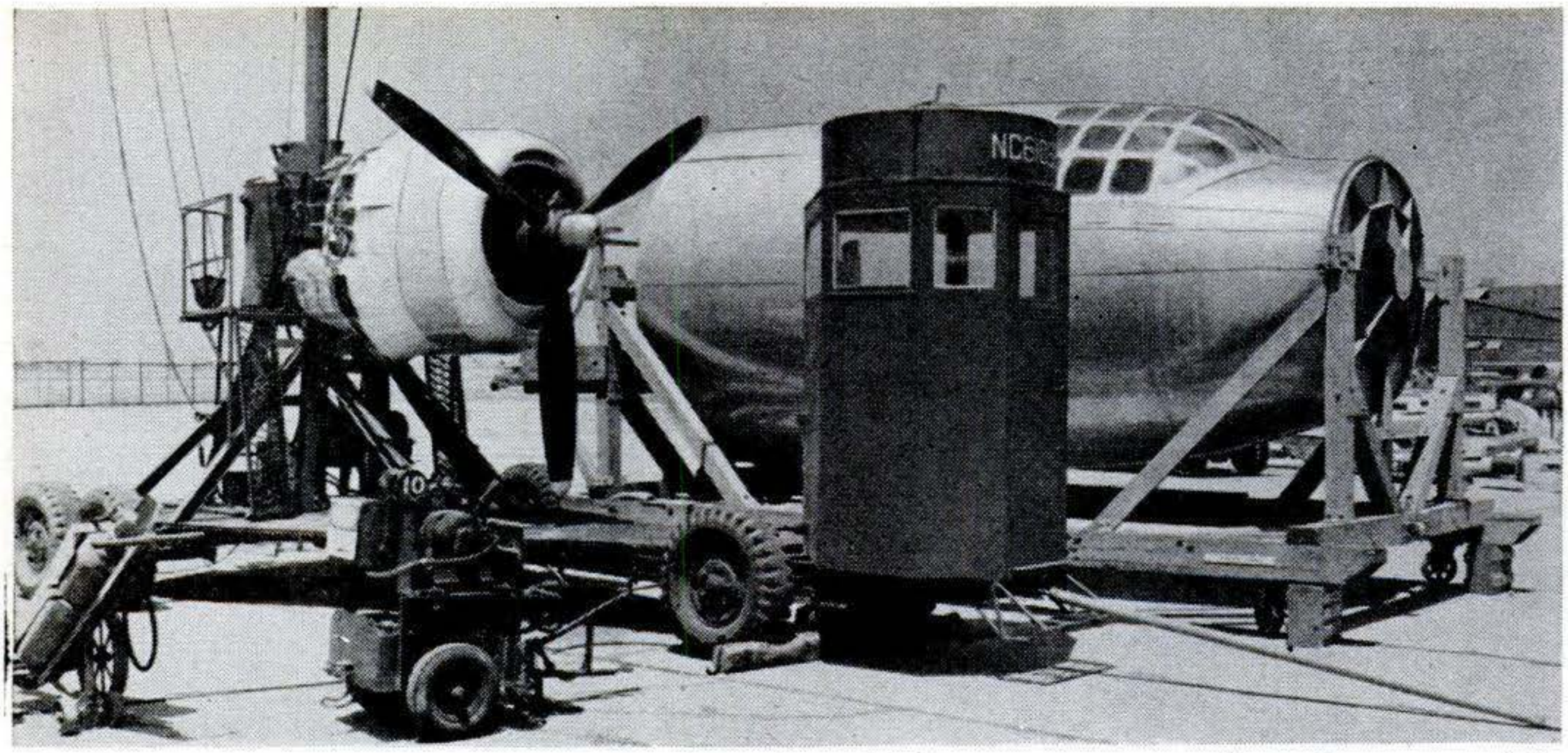

Convair engineers use this fuselage of a salvaged plane to test soundproofing materials.

residents put up a strong fight to abandon Newark Airport as an international field; Baltimore introduced an ordinance (fortunately defeated) to prohibit all air traffic over the city; a Southern California dairy farmer recently sued an adjacent airport and won $5,000 because noisy planes upset his cows.

By far the most serious threat to aviation (if it had been adopted) was a recommendation by air veteran Grover Loening that a noise limitation of 70 decibels at a distance of 500 feet be made a law. That would have permanently grounded all airplanes in the United States.

What About Jets?

All this fuss does not take into consideration the jet and perhaps rocket-powered air transports of tomorrow. At a meeting of the American Society of Mechanical Engineers, Kenneth R. Jackman, chief test engineer of Consolidated-Vultee Aircraft, reported that in the bare cabin of a jet plane with engine running, the noise level was 121 decibels. He also told of standing near the tailpipe of a jet—after five minutes he experienced "an unbalanced sensation and dizziness."

A few months ago I was at an Army Air Forces base when test-pilot "Slick" Goodlin tried out the rockets of his experimental XS-1 on the ground before being borne aloft under the belly of a B-29. The combined vocabulary of some 50 newspapermen and aviation writers couldn't describe the resulting noise, which evidently blew the top off the decibel scale.

Silencing the airplane enough to appease the public is generally conceded to mean lowering the present over-all noise level of 100-110 decibels to 85. With progress being made decibel by decibel, that's a long way to go. The only real solution is to eliminate aircraft noises at the source.

Today the propeller is airplane Public Enemy No. 1, even though exhaust noises may be almost as loud. That's where the decibels get their licks in again. Since decibels are a logarithmic function rather than a physical quantity, two simultaneous equal-intensity noise sources do not double the sound level but simply raise it three decibels above one noise source. So completely eliminating the slightly lower exhaust noise will accomplish nothing so long as the higher propeller noise exists. Again, there is little to be gained by silencing the propeller unless the exhaust is hushed.

It has been known for years that propeller noise can be reduced greatly by lowering the tip speed of the propeller blades, using more or longer blades. But one manufacturer of light planes (loudly buzzing flies in the noise ointment) states that the use of three blades instead of two would increase a propeller's weight by 60 percent, its cost by several times.

Recently, however, the National Advisory Committee for Aeronautics confounded the "no can do" faction by flying an experimental plane that at 300 feet, according to observers, made no more noise than a glider. The plane was a modified Army Stinson L-5. Instead of two blades rotating at 2,000

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NACA plane does silencing job with a five-bladed, geared-down prop and an engine muffler.

r.p.m., it had five stubby blades rotating at 1,000 r.p.m., which practically eliminated the propeller-tip whine. The exhaust noise, which would have canceled this gain, was taken care of by an oversize muffler. Overall noise was reduced from 90 decibels to 66, enough to placate the most critical citizen—if cost permitted general application.

Mufflers, once propellers are made quieter, become a problem in themselves. Mufflers have been devised that work, but they, too, boost costs and weight—and often reduce engine efficiency.

Making Silencing Pay

Curtiss-Wright, however, has developed a system that pays for itself by utilizing exhaust gases to give added power to reciprocating engines by means of a rear turbine wheel, at the same time cutting down noise considerably. So by the time the propeller problem has been solved, engineers may have licked the exhaust racket.

As these major noises are reduced, "engine clatter" emerges. Low in the decibel scale, this includes the noises of rotating parts, carburetor, gears, etc. When they become important, improved vibration insulation between the engine and its mounting will all but eliminate them.

For the airplane passenger, a great deal has been done in cabin soundproofing. Fiberglas is considered one of the best blankets for this purpose. In a Stinson Voyager, it has reduced cabin noises so much that static on an overhead radio loudspeaker became annoying.

In soundproofing, however, weight again must be considered. Theoretically, you could soundproof a cabin to pin-drop quietness, but the added weight would certainly make the plane too heavy. Consolidated solved the weight problem in the new Convair 240 by using two inches of spun glass layer-caked between strips of plastic film. Total weight, including trim cloth, is only 325 lb., as compared with previous methods that added about 900 lb.

Another noise-killer is a "floating cabin," in which the sidewalls and ceilings are mounted in rubber and at no point attached directly to the fuselage. Experiments on one transport indicate that this method will achieve a new low in cabin noise and reduce vibration by 60 percent.

Then there are the interior cabin noises, such as high-frequency whistles of ventilators, imperfectly fitted doors and leaky windows, which can raise the noise level by 20 decibels. These all add to the problems that must be solved by acoustical and aircraft engineers. And with pressurized and air-conditioned cabins come new sources of noise: compressors, expansion turbines, etc.

But we can look forward to an air liner with geared engines driving multiple-bladed propellers, the exhaust muffled, the cabin soundproofed, cruising almost noiselessly at 300 to 400 m.p.h. Even then, though, there is a catch—at high speed, the noises caused by the flow of air over the plane may emerge from their present obscurity.

So it looks as if acoustical engineers, like the airplane, are here to stay. END

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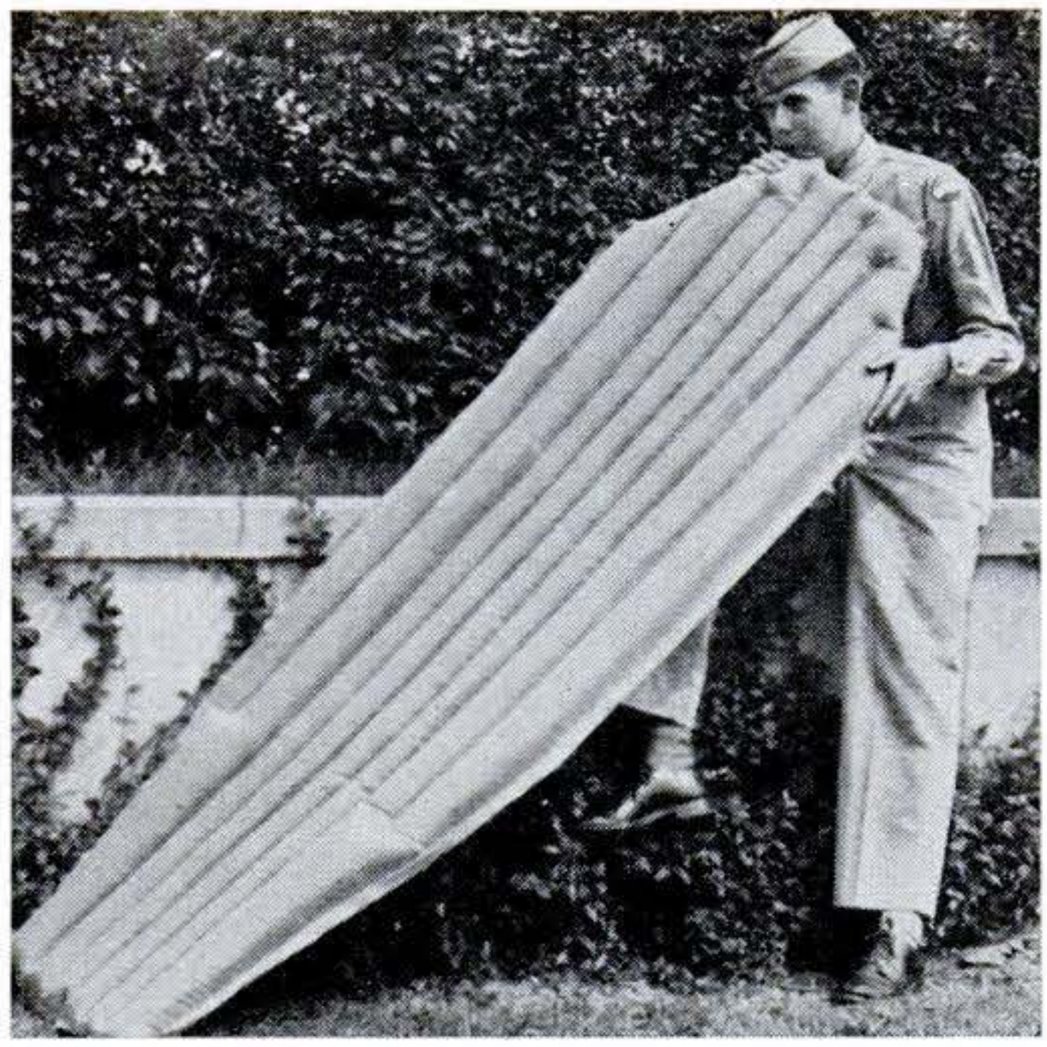
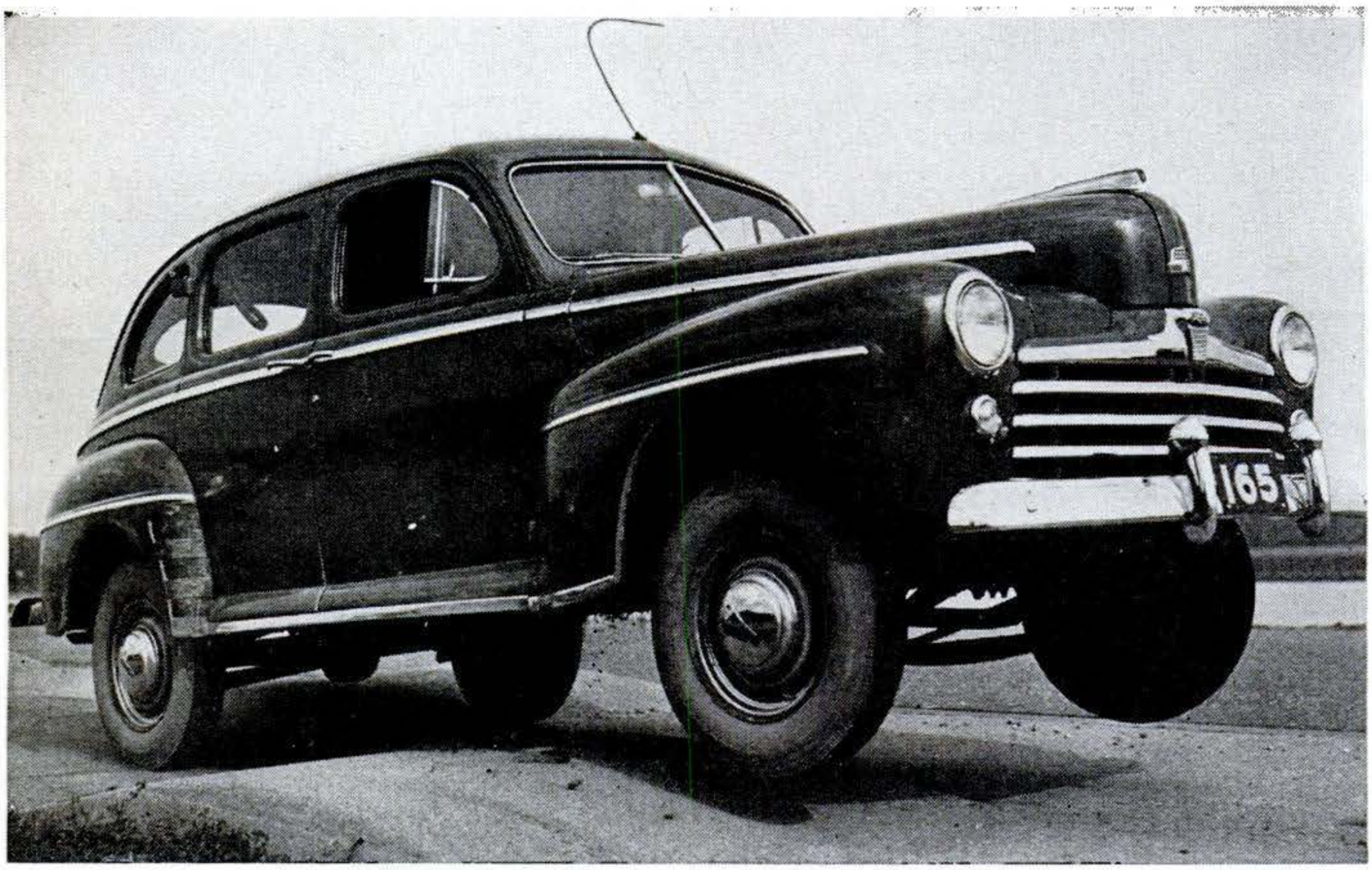
Scooter Goes Rural

WEARY of endless plodding, California farmers are using motor scooters like this Salsbury for tending irrigation ditches. Low center of gravity, jolt-absorbing wheel suspension, and automatic clutch and transmission help the two-wheelers do a good job on rough terrain.



Mattress Kills Chills

MUMMY-SHAPED to save weight, this new 56-oz. Army mattress allows troops to sleep in the snow. It is blown up to provide an insulating dead-air space, lacking in blankets when crushed beneath the user. Made of rubber-coated nylon, the mattress is hollowed to keep the sleeper from rolling off.



Twists Test Bodies

THIS Ford is leaping into the air on one of its 200 trips around the "body-twist" course at the Dearborn test track. Here body and frame are subjected to extreme torsion stresses—first in one direction, then the other—as indicated by the whipping aerial. The test is one of a series that experimental Fords must undergo.

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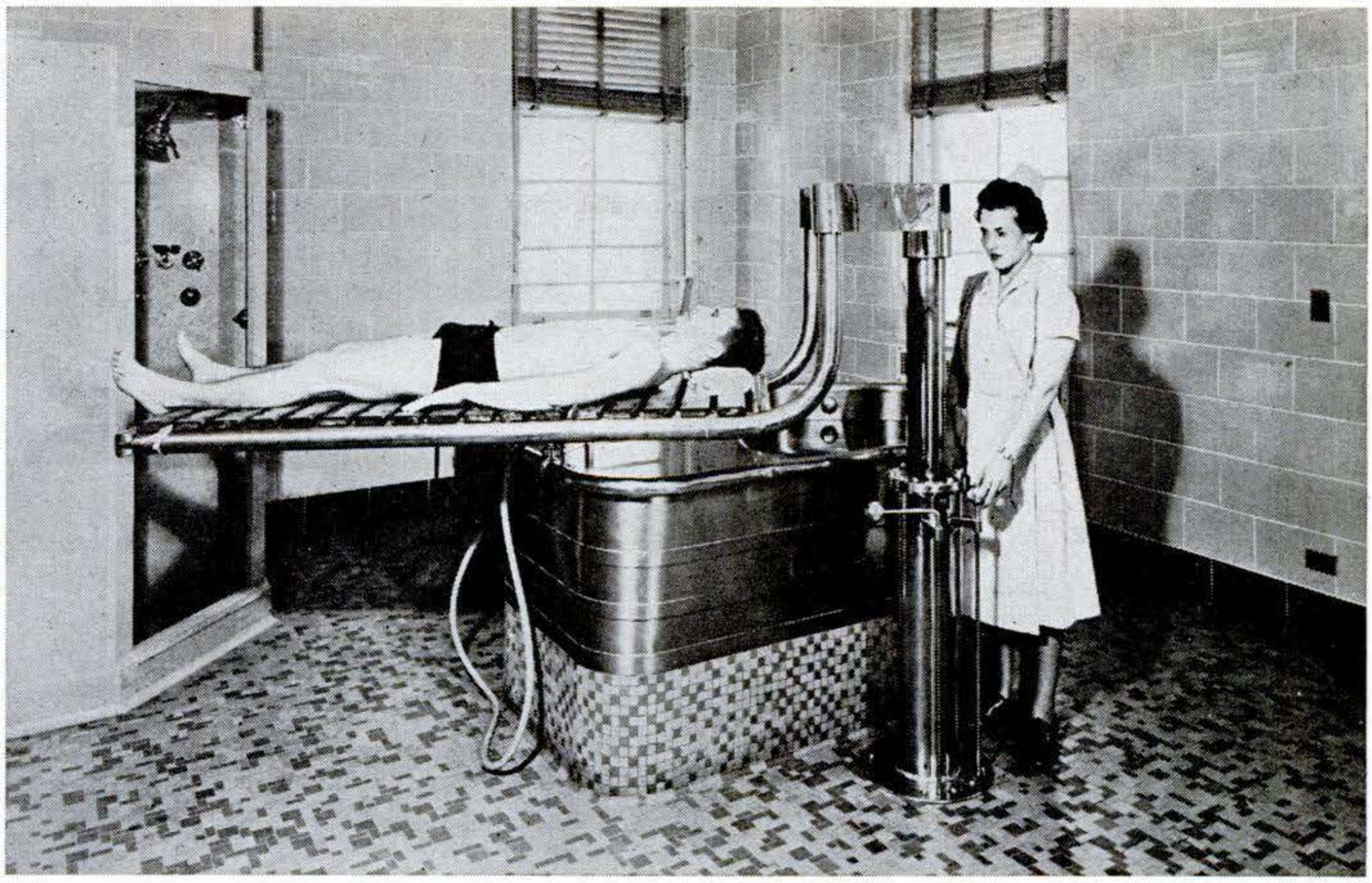
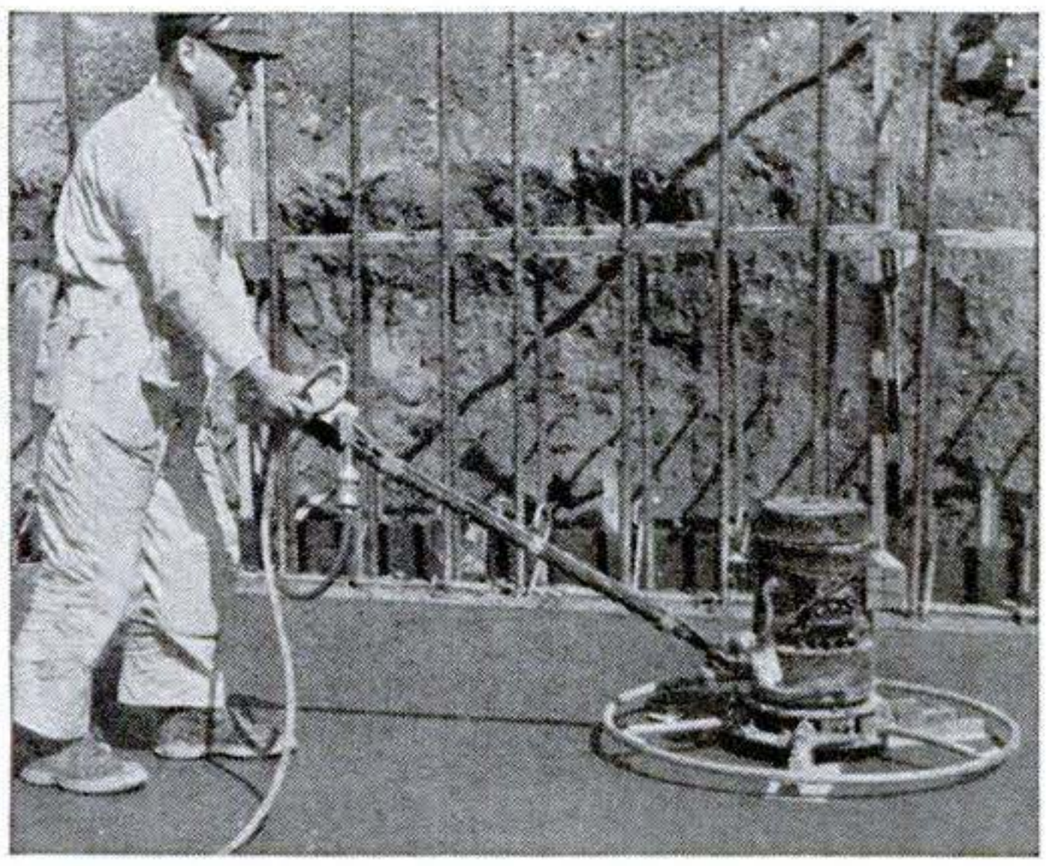


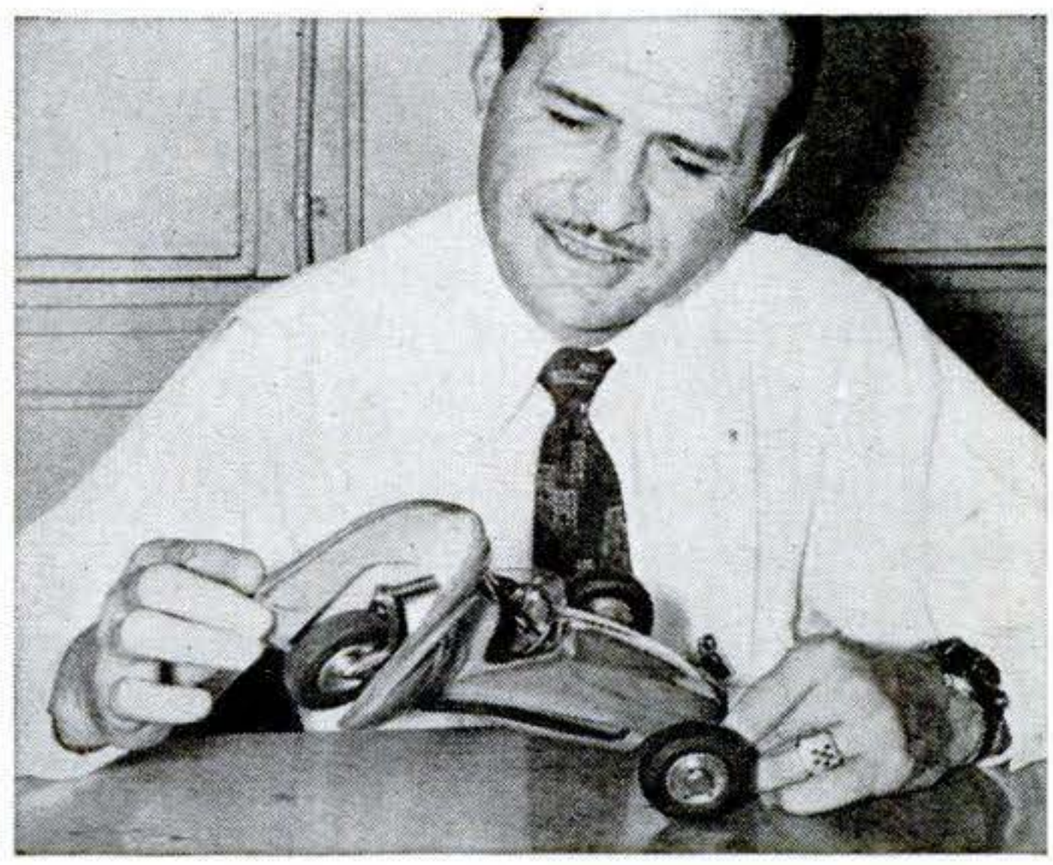
Patients Get a Lift

LIFTING hospital patients into and out of hydrotherapy baths is easy when this specially designed hoist is used. The patient is supported on a pallet of wood and steel, attached to a hydraulic plunger, which can be swung in a complete circle. Valves on the cylinder control the "elevator," which is made by the Globe Hoist Co. Obtaining its power from compressed air, the device can support a 500-lb. weight.



20-Manpower Trowel

WITH this electric trowel a man can smooth concrete 20 times as fast as by hand. As its four blades are rotated by a ½-hp. electric motor, they both vibrate the concrete and smooth its surface. The vibration brings the finer grains to the surface, resulting in an extra-smooth finish. The trowel was built by engineers of the Metropolitan Water District of Los Angeles.



Fin to End Skids

THIS new three-wheel racing car has a large hydraulic fin to prevent skids by creating air resistance. A front-wheel drive model, it is designed by Edward J. Shermeister, of Sheboygan, Wis. The model of the car shown above is being examined by Wilbur Shaw, president of the Indianapolis Motor Speedway, where the full-size car will be entered next year.

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MECHANICS OF LIVING

How Your Electric Refrigerator Works

FOR three out of four American families, electric refrigerators have replaced the old-fashioned icebox and drain pan on the back porch. Besides standard models, household types now available include two-temperature refrigerators, combining space for ordinary food storage with a low-temperature compartment for storing frozen food; and home freezers that do the quick-freezing, too. All of these modern developments apply a simple natural law.

On a warm day you perspire, because perspiration cools your skin as it evaporates. When any liquid turns to vapor, it chills whatever it touches. Therefore the key part of an electric refrigerator is a place where a liquid, the refrigerant, continually evaporates. The ice-cube compartment of a standard refrigerator serves as its evaporator, and is therefore its coldest spot. It freezes water placed within it and cools the rest of the food storage space.

Obviously there must be some provision to replace the liquid refrigerant that evaporates. Therefore, the vapor is not allowed to escape, but is turned back into a liquid so that it can be used over and over again.

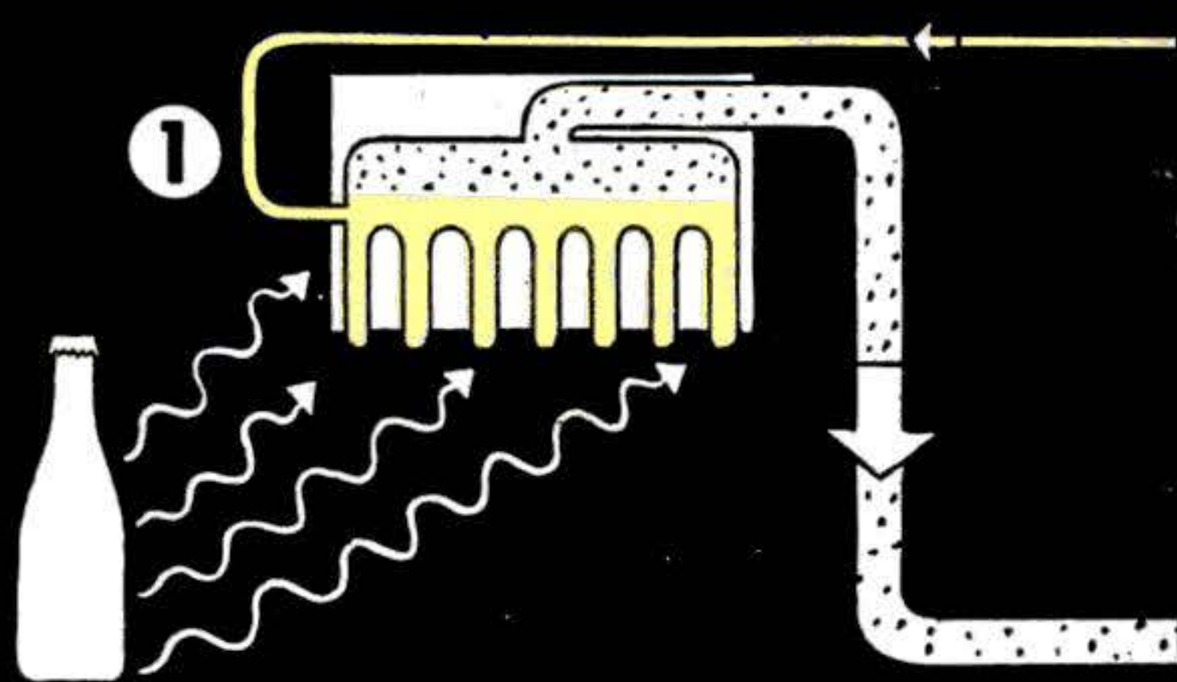
Any gas, even air, liquefies when you get it cold enough. It will turn into a liquid at a much higher temperature if you apply pressure. In fact, if the boiling point of its liquid form is not unreasonably low, a vapor will liquefy at room temperature under pressure alone.

Such a substance is used in mechanical refrigeration. Most household refrigerators employ Freon 12, sulphur dioxide, or Freon 114, which have boiling points of −22°, +14° and +38° F., respectively, at normal atmospheric pressure. Under the pressure supplied by a compressor, they readily turn from vapor to liquid at a room temperature as high as 100 degrees.

Since a gas gets heated when a piston compresses it, the surplus heat has to be removed to allow the gas to condense. This takes place in the refrigerator's condenser, which may be a small finned coil past which an electric fan blows a stream of air to dissipate the heat. In other models, it is an extended coil mounted on the back of the refrigerator cabinet.

Connected together, these essential parts form a hermetically sealed system in which the refrigerant circulates, abstracting heat from the cooling compartment each time it passes through. Designed for maximum outside temperature, the capacity of the cooling system when running constantly is normally much more than sufficient, and therefore a thermostat automatically turns it on and off as needed.

Typical electric refrigerator, shown on opposite page, works like this. A bottle of soda water, at room temperature, is put in refrigerator to chill. Liquid refrigerant, turning to vapor in evaporator (1), absorbs heat conveyed from bottle by natural circulation of air in food compartment. Suction pipe leads vapor to compressor (2), which puts it under enough pressure to liquefy when heat of compression is dissipated to surrounding air by condenser (3). Liquid flows to evaporator and cycle is repeated.



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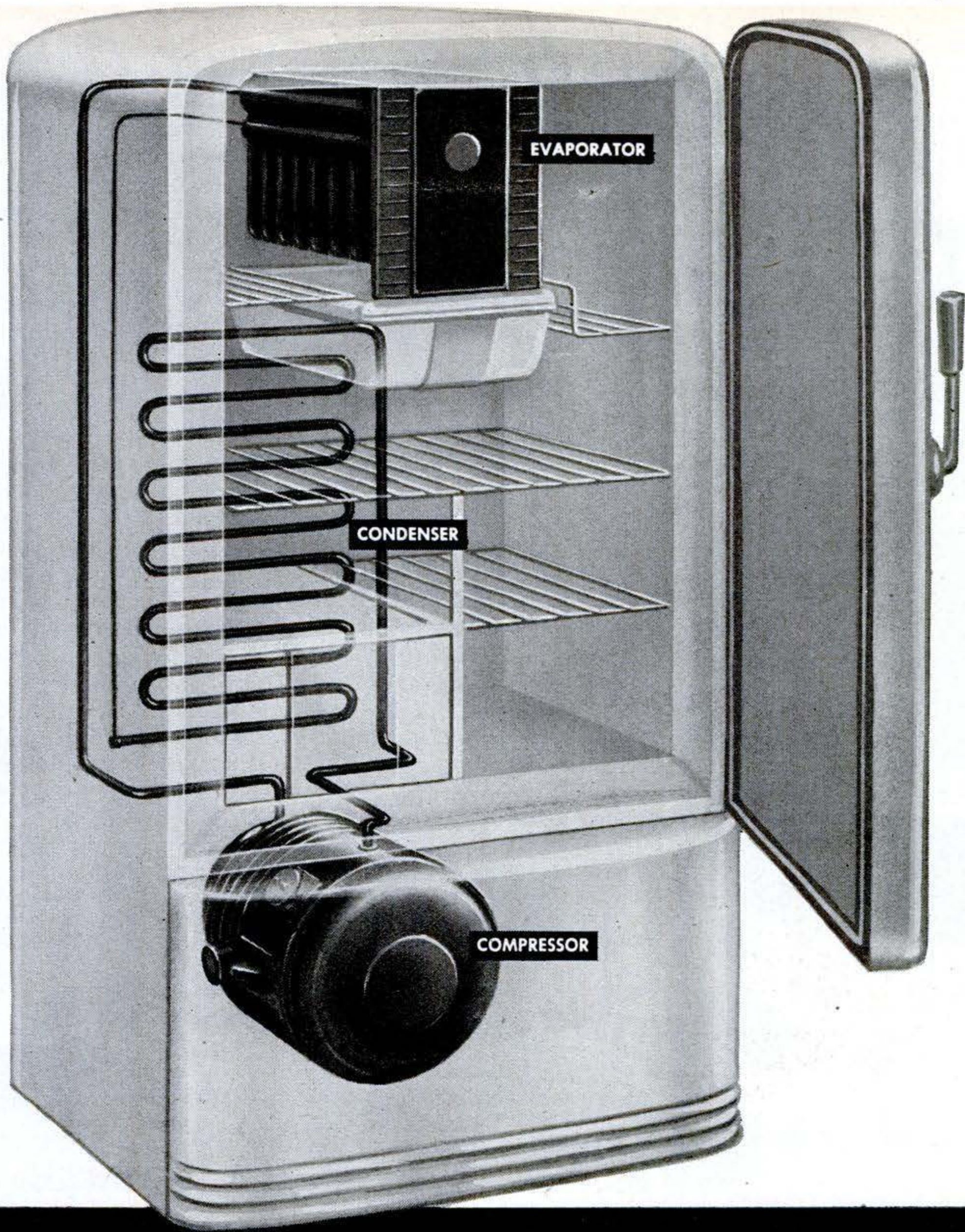

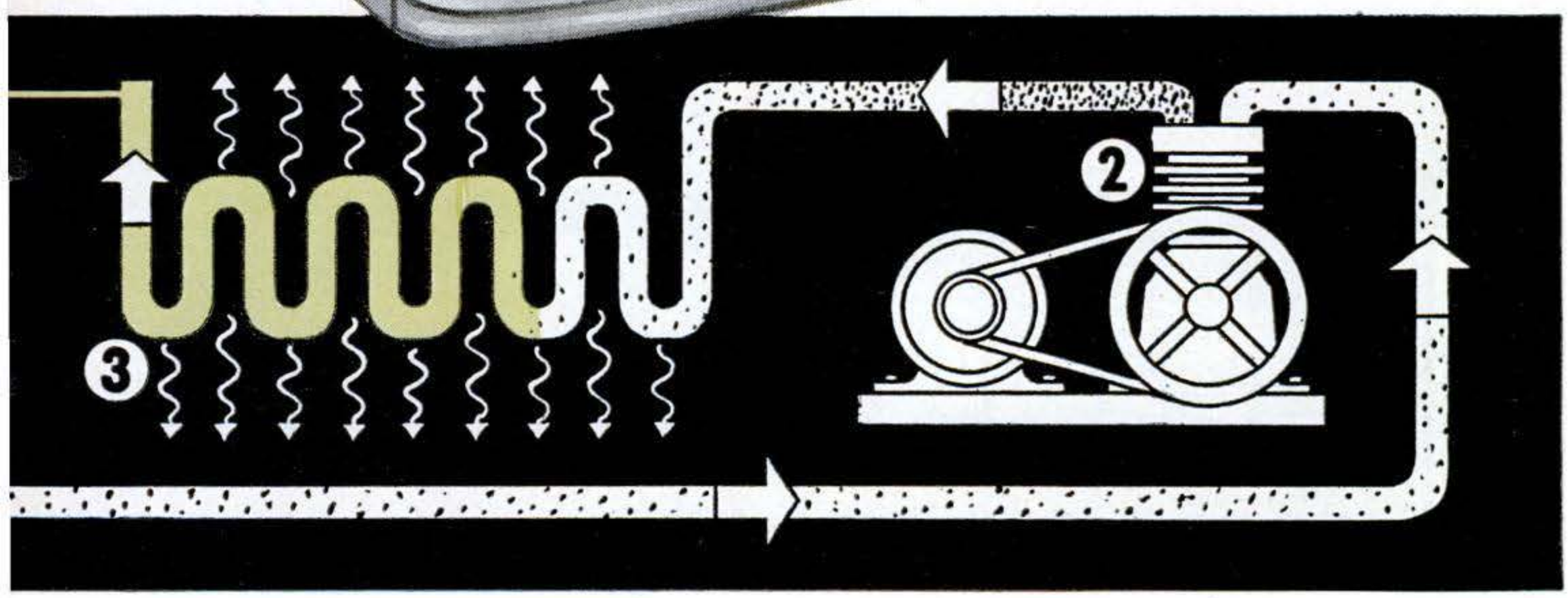

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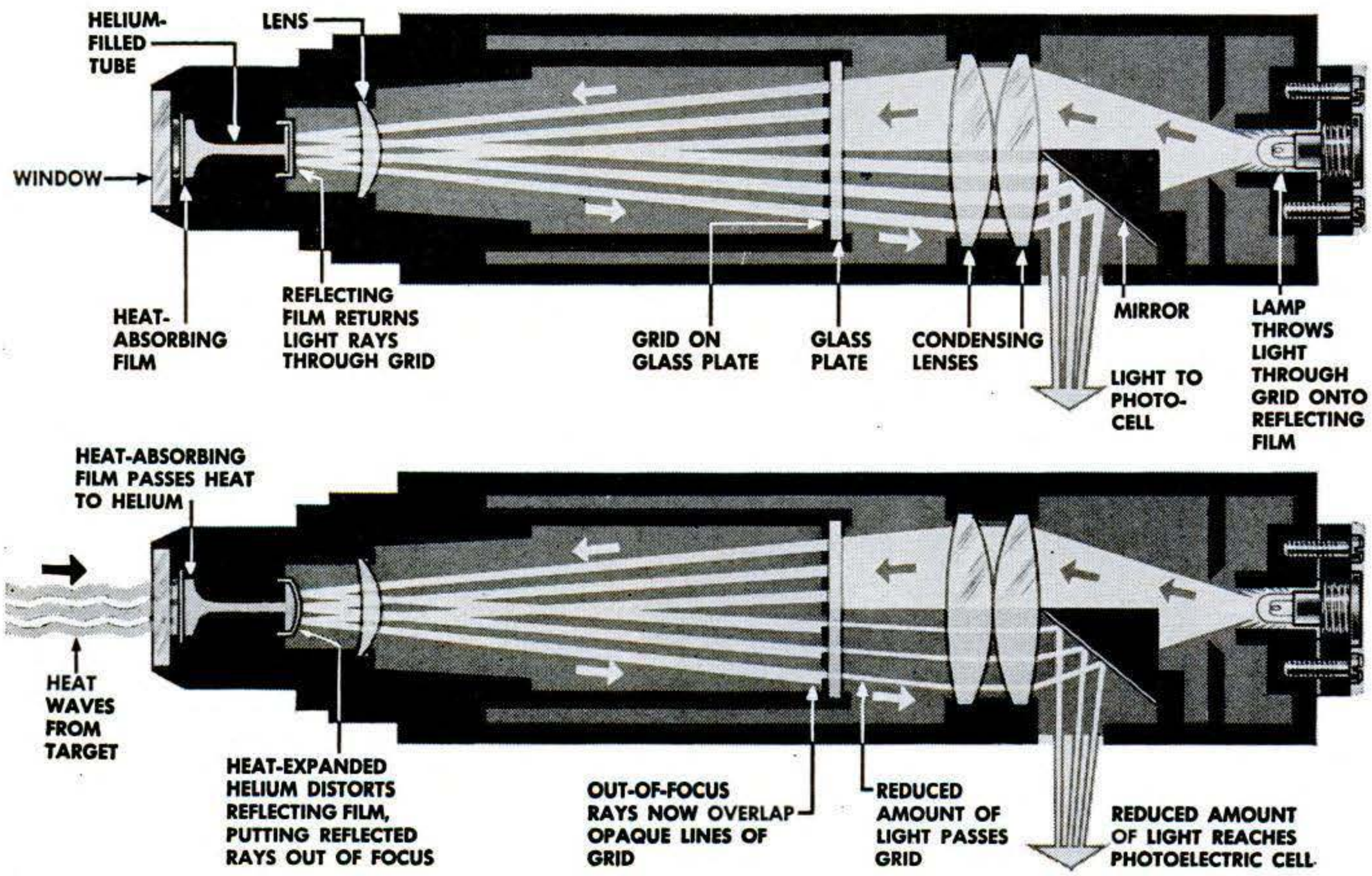
Teletherm Tracks Target by Heat

LESS than ever now can the dark of night hide military operations. The Teletherm, latest night detector, is no bigger than a couple of large suitcases, but it can pick up a steel mill at 15 miles or a truck at three or four—and put a recognizable picture of the target on a cathode-ray screen. Developed by Dr. Marcel J. E. Golay, of the Signal Corps Engineering Laboratories at Bradley Beach, N. J., it is activated by heat from planes, tanks, or even a soldier's body.

The Teletherm's camera has a rock-salt lens that focuses heat rays from the target on a scanning mirror. This scanner, similar to one used in the mechanical television cameras, is moved by an electric motor back and forth 50 times a second and up and down five times per second. The heat rays it picks up are reflected to a photothermal detector that converts them into electrical impulses. These are amplified and transmitted to the thermovisor, much like a television receiver, where they create the target image on the viewing screen.

The heat-sensitive detector is what makes the Teletherm different from the superconducting bolometer developed at Johns Hopkins by Dr. D. H. Andrews (PSM, July '46,

Tiny detector tube (left, above) uses light to turn heat waves into electricity, as diagrammed below. Top drawing shows normal situation; bottom, what happens when heat hits tube. More heat would spread rays farther, cutting off more light.



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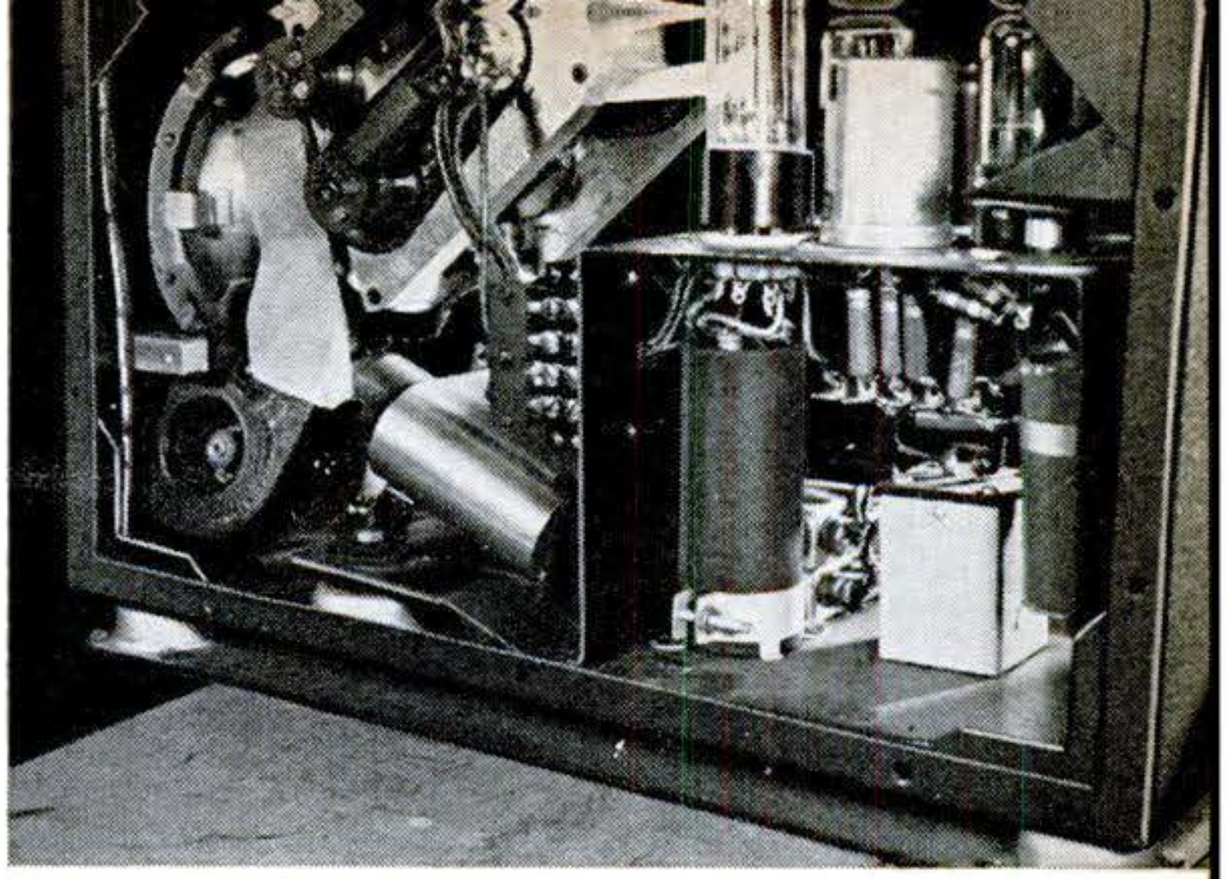
Teletherm camera, on right, has lens of rock salt, which transmits heat better than glass. At left is receiver, called a thermovisor.

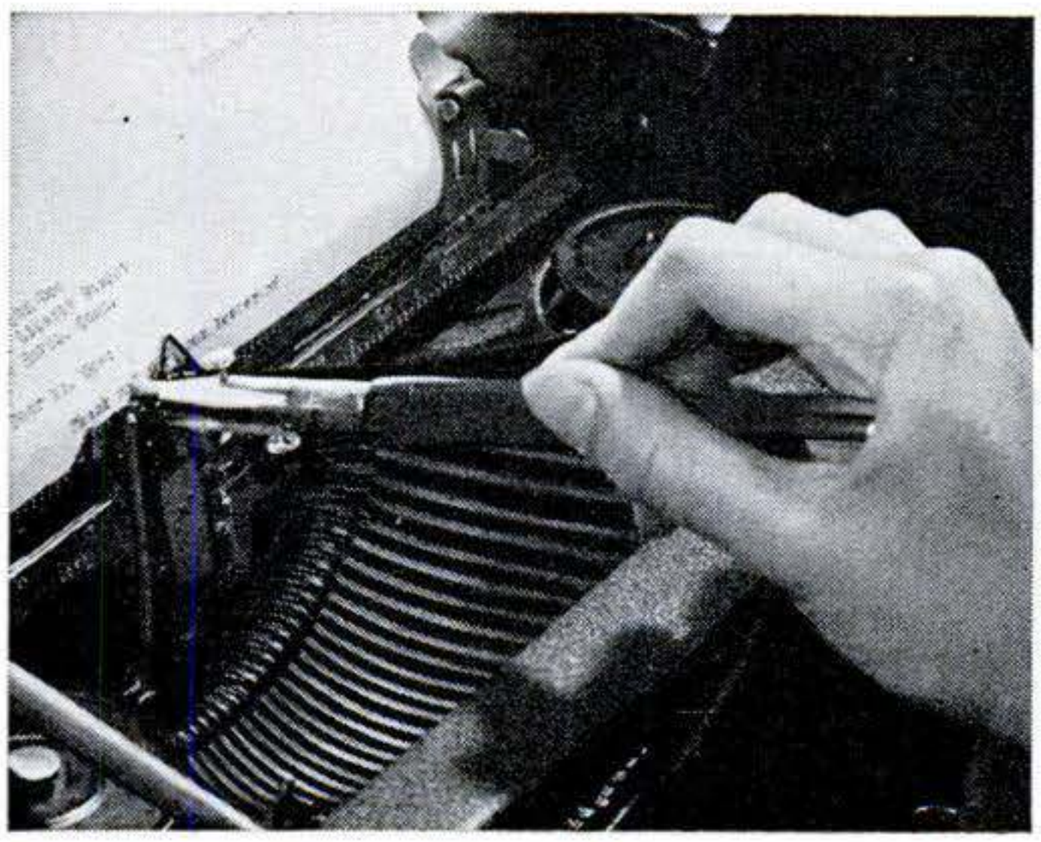


Interior of Teletherm camera shows compact construction. Reflector behind lens is at far left; heat-sensitive tube is at lower left center.

p. 126). The Teletherm detector is much smaller and, unlike the Andrews device, it is not complicated by the need for insulated cans of liquid hydrogen and nitrogen.

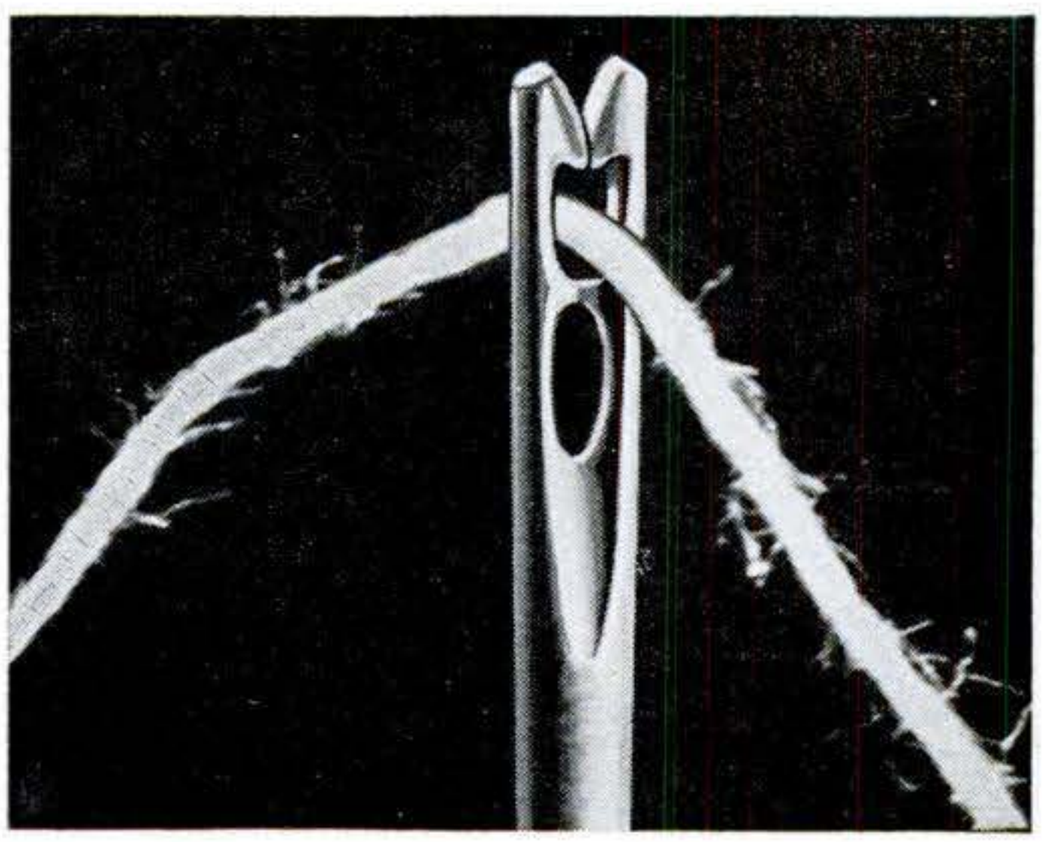
Heart of the detector is a very small helium-filled tube sealed at each end by a thin plastic film. The forward film, less than a millionth of an inch thick, is coated with aluminum to absorb heat from the target. This heat warms the helium, expanding it so that it bulges the rear film, which is antimony-coated to form a flexible mirror.

The mirror is part of the tricky optical system that regulates the amount of light reaching a photoelectric cell. Current from the photocell controls the viewing screen. The more heat absorbed by the detecting film, the greater the bulge in the flexible mirror, and the smaller the amount of light reaching the photocell. Through proper connections with the amplifier feeding the viewing screen, this reduction in light is translated into a brighter spot on the screen. A hot target makes a very bright spot. END



Spins Errors Away

THE problem of neat erasures and what to give your secretary for Christmas can be solved by the SpeedEraser. Pencil-shaped, it has a notch that fits the typewriter key guide and centers the one-character-wide tip on the error. Pushing the shaft then rotates the eraser on the paper, removing the mistake but leaving no smudge. Made by Blue Robin Corp., of New York City, present models fit all but noiseless typewriters.



Needle for the Blind

THE needle shown above can be threaded by sense of touch alone, so blind persons can use it without assistance. The thread is pulled down between two notched prongs, somewhat like the tines of a miniature fish spear, that trap it in place. Made in England, the needle is available without charge to any blind person in this country who desires it. It is being distributed by the New York Guild for the Jewish Blind.

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How to Fly a Helicopter

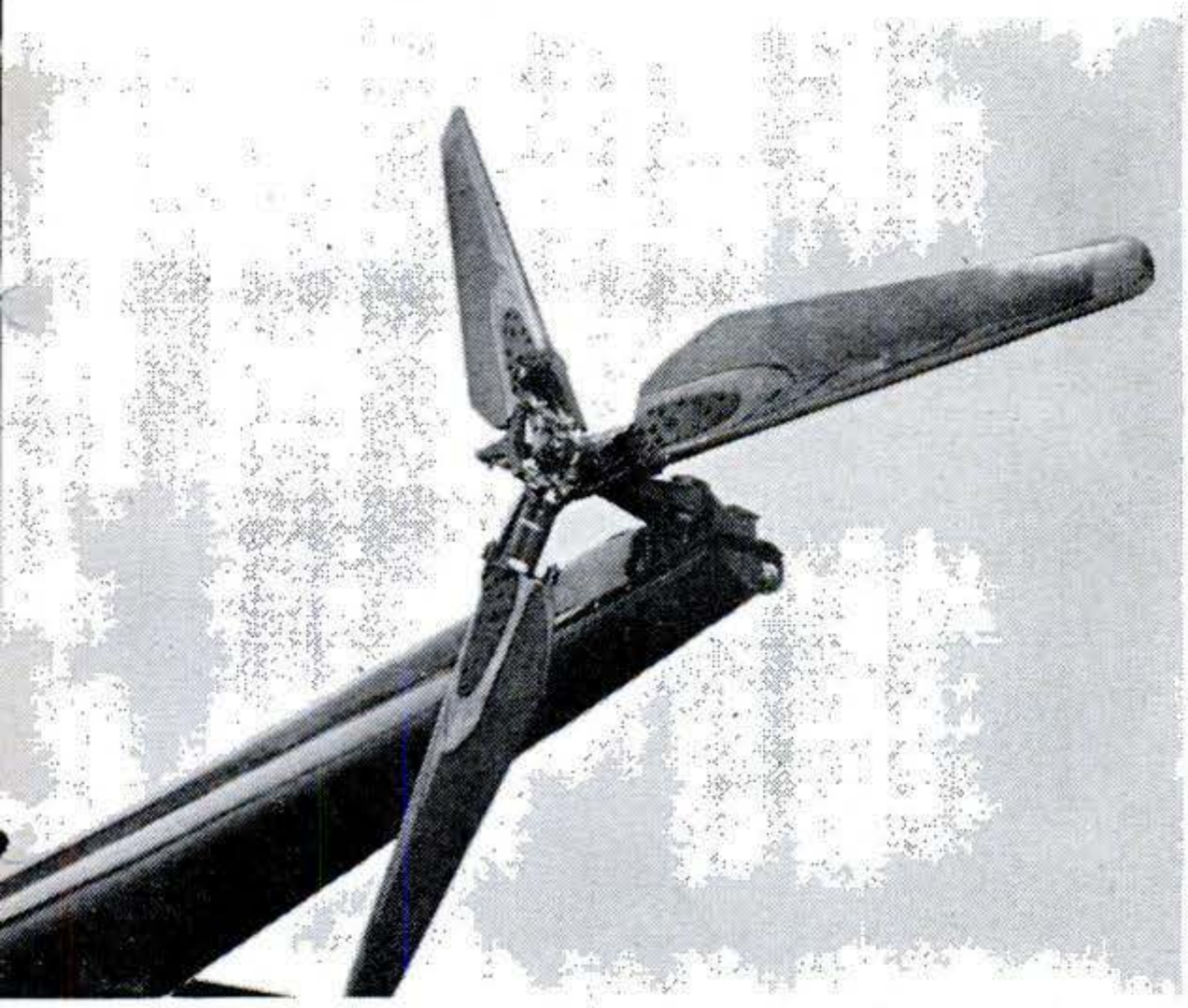
Your Sikorsky S-51 is on the left. Weighing 2½ tons, this four-seater cruises at 80 m. p. h. on its 450-hp. engine. It is 12 feet high and 57 feet long, counting the overhang of the blades in front; the diameter of the main rotor is 48 feet. The smaller 'copter is a Bell two-seater.

Most dials and switches on the instrument panel are the same as those in a conventional plane. Rotor and engine speeds are shown on extreme right dial of middle row; rotor brake is white handle at left of lower group of toggle switches. Stick in lower left foreground controls pitch of the main rotor. White column partially hidden at right is cyclic control stick. Rudder pedals in the background change the pitch of the little tail rotor that steers the 'copter.

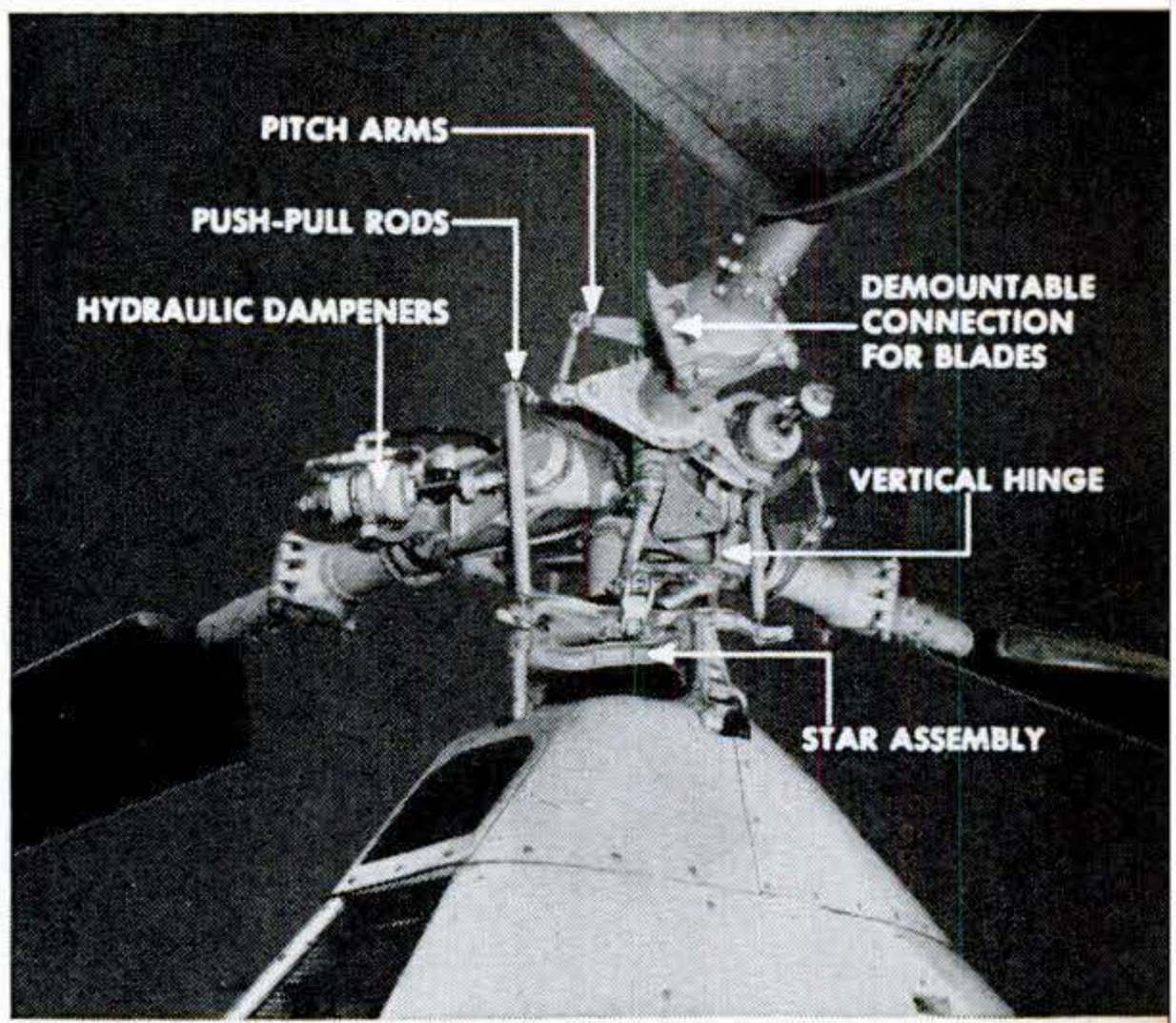
Your instructor, pilot Roy P. Beer, of HAT, shows you the "driving" position. His right hand is on the cyclic control stick that determines direction, his left on the pitch control that rules altitude. His feet are on the rudder pedals. The throttle is integrated with the pitch control—the greater the pitch of the rotor blades, the more power is needed. For fine power adjustment, you twist the grip on the pitch lever just as you would a motorcycle throttle.

FOR your training flight you have the use of a $70,000 Sikorsky S-51—and Helicopter Air Transport of Camden, N. J., will charge you $2,000 to learn to fly it. When you start, just remember that it's as complicated for a regular pilot as a plane is for an auto driver. A 'copter is both lifted and propelled by its main rotor (PSM, June '44, p. 57). To go up or down you increase or decrease the pitch of the rotor blades. To move horizontally you also change the pitch, but for only part of each rotation—decreasing it in the sector toward which you wish to move, increasing it on the opposite side. This is "cyclic" pitch control.

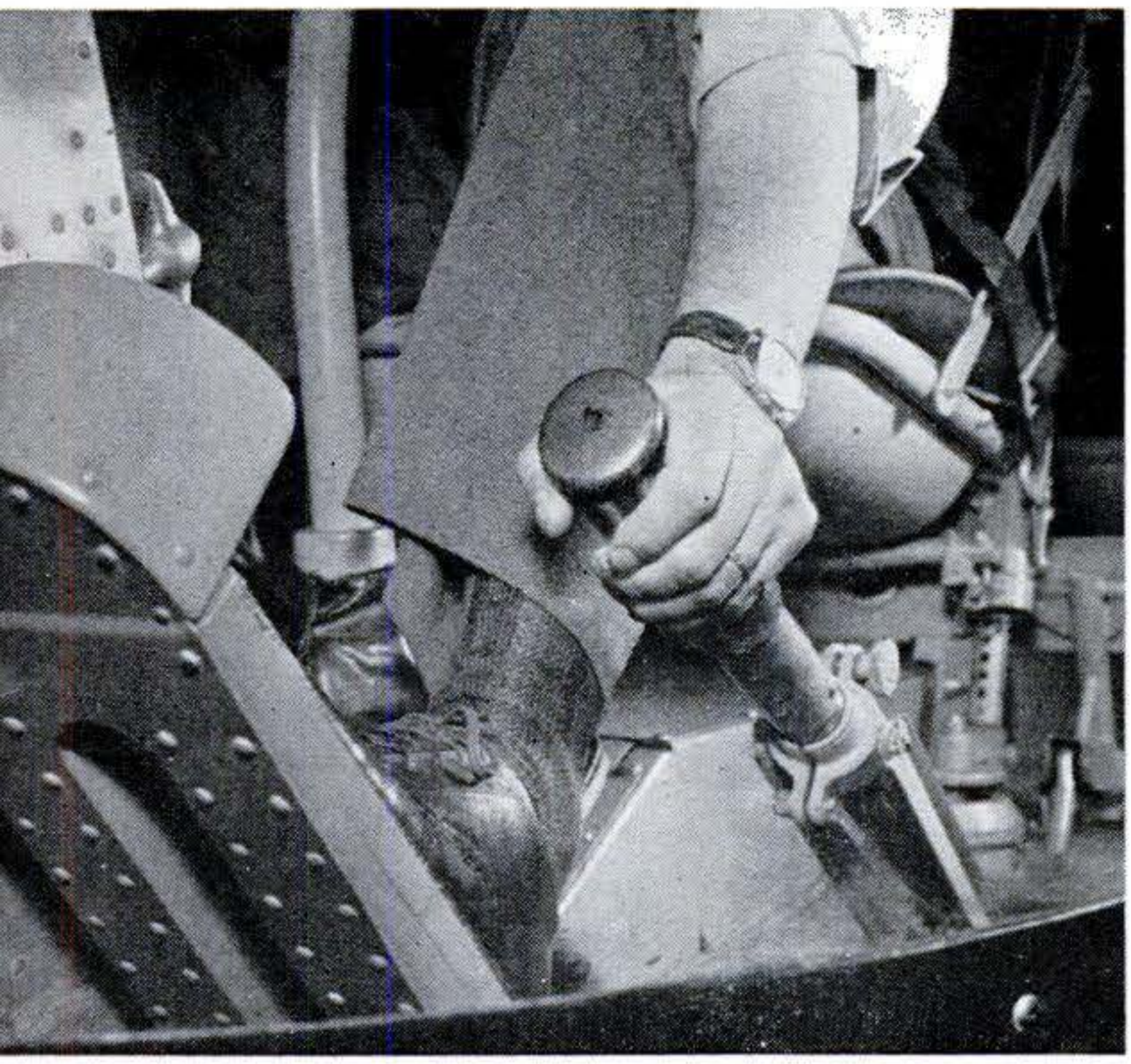
PSM photos by W. W. Morris



This little tail rotor steers the 'copter by kicking or sucking the stern around according to the setting of the reversible blades, here at full right rudder. It also keeps torque of the main rotor from swinging the fuselage around.



This is the position your rotor blades—stilled for the photographer—assume to go aloft. Hydraulic dampeners keep the blades from swinging too far back and forth on their vertical hinge assemblies as they rotate.



Starting your engine, make sure the pitch lever is all the way down, minimizing upward pull. This is also correct position in case of dead-stick landing after engine failure, when the blades autorotate and ease you down.

To take off, you bring the pitch lever about halfway up and move your control stick slightly forward to compensate for any wind on your nose and permit a straight-up ascent. The engine roars and you leave the ground.

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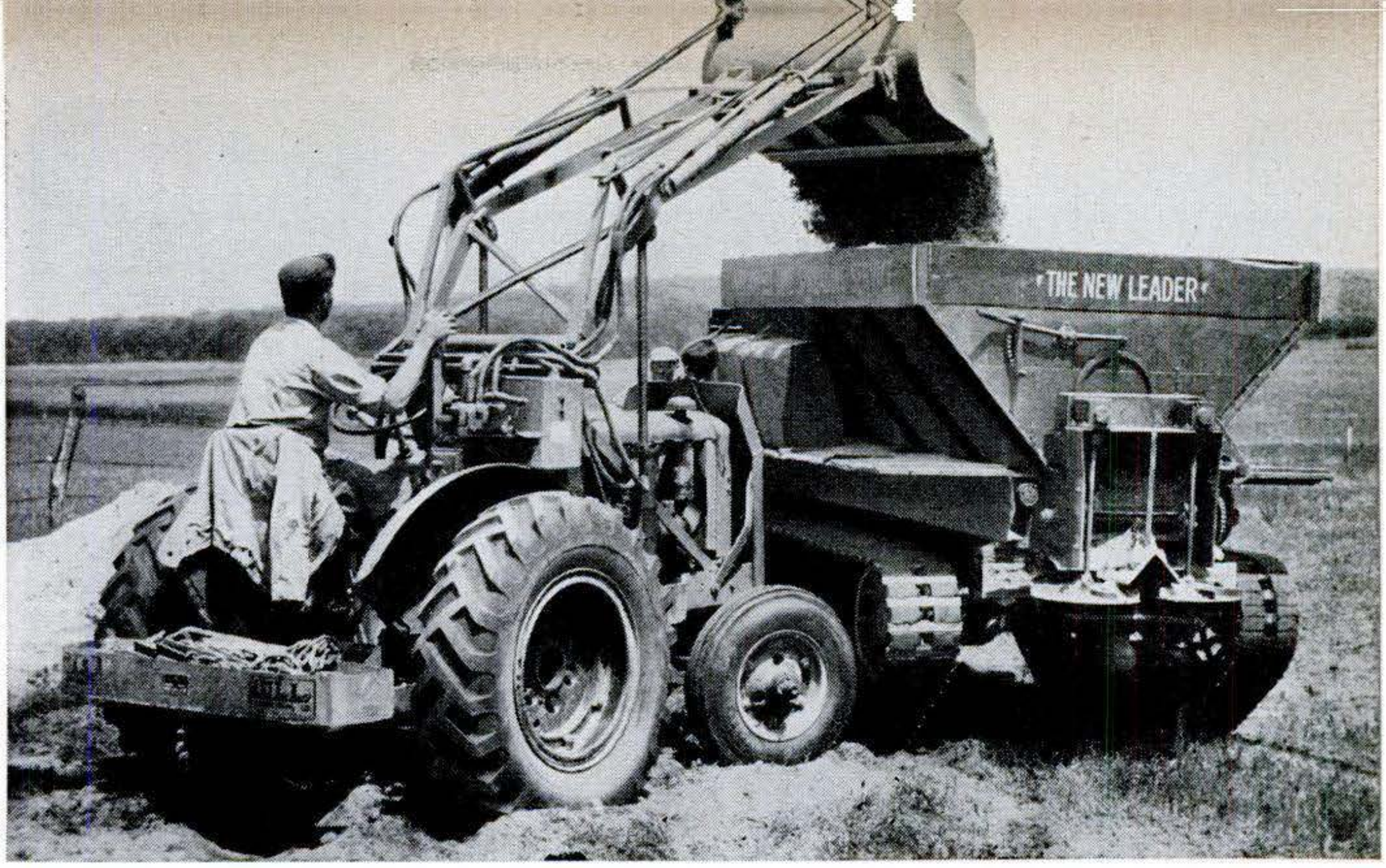
In the air, you keep your 'copter on an even keel by working the cyclic control stick just as you would the stick of a conventional plane for straight and level flight. To start climbing and gain forward speed you pull up the pitch control—increasing rate of climb to 800 feet a minute—and push the stick forward. This decreases rotor pitch in forward part of the orbit and increases it at rear, so that the 'copter noses slightly down and pulls ahead.

For a right turn, you push the right rudder pedal and the rear rotor pulls the stern of the helicopter around. At the same time you pull the control stick to the right, changing the cyclic pitch of the rotor so that the craft sidles in that direction. The pitch control is held about halfway back to keep the altitude constant. If you wish, you can fly backward or sideways with your stick alone, keeping the 'copter's nose dead ahead with your rudder pedals.

To land, you push the pitch control down to lose altitude and the craft glides forward at 50 m. p. h. Now come full back on your stick while reducing pitch a little. This brings up the nose and stops the helicopter dead in half the distance an auto needs at that speed. Now ease her down with pitch control, using a little left rudder to offset reduced torque. P. S.: If this had been your first solo, you would have been allowed to rise only a foot from the ground!



A tractor loads the half-track with lime for the fields; no laborious shoveling here.

Half-Track Gets Farm Job

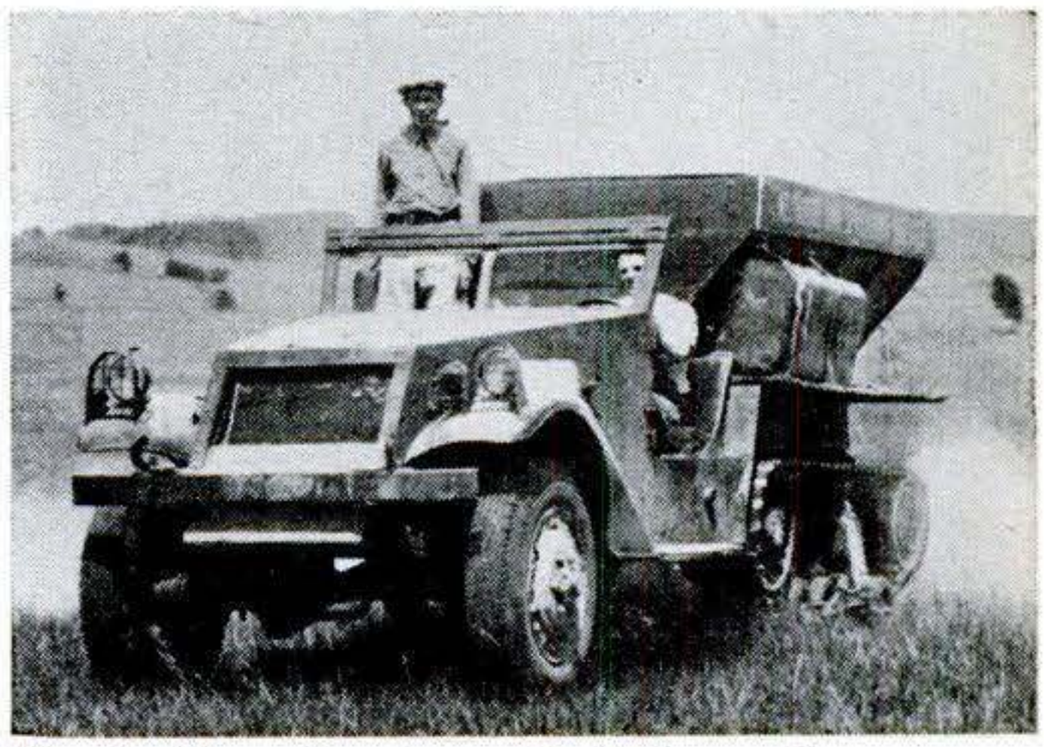
AN ARMORED half-track, built to haul troops and cannon into battle, has started civilian life down on the farm. Scattering lime over depleted fields, it spreads as much as 100 tons a day. Rumble and rock though it may, the half-track offers many advantages over both truck and hand distribution.

Another veteran, Clem Neuheisel of Eau Claire, Wis., is responsible for the conversion. Neuheisel came back from the war to enter the lime business with his brothers. They found that trucks, excellent on level, firm ground, couldn't negotiate the rugged Wisconsin hills and were often hub-deep in Eau Claire County's sandy soil.

Neuheisel remembered the half-tracks he'd seen conquer similar terrain during the war. He bought a surplus model and had mechanics strip off the heavy defensive armor. A spreader box was then installed with a power take-off from the motor. The whole job cost about $2,400—half to buy the machine and half to convert it.

By now the machine has shown that it can earn its keep and then some. Its 100-ton daily spreading capacity—its spread is 25 feet wide—beats that of a truck by 25 to 50 tons. It is far ahead of the 20 to 25 tons that a two-man crew distributes daily.

The tracks carry the vehicle easily over rugged hillsides and through sandy soil that would stop trucks cold. The wide tracks not only reduce traction pressure but keep the vehicle from rutting the hillside the way truck tires do. Thanks to its wide wheelbase, the half-track has a long span of usefulness during the growing season. It can be run through the cornfields after planting until the corn is a foot high.



The half-track, stripped of its wartime armor, goes to work spreading lime. It can work where ordinary trucks would stick or stall.

Neuheisel is now looking around for other jobs for his converted veteran. Already it has been suggested that its great traction area makes it a natural for spreading sand on icy winter highways.

In the meantime, Neuheisel has already bought another half-track for his lime work and he's planning to add two more. The half-track is a veteran who has really made good in civilian life.

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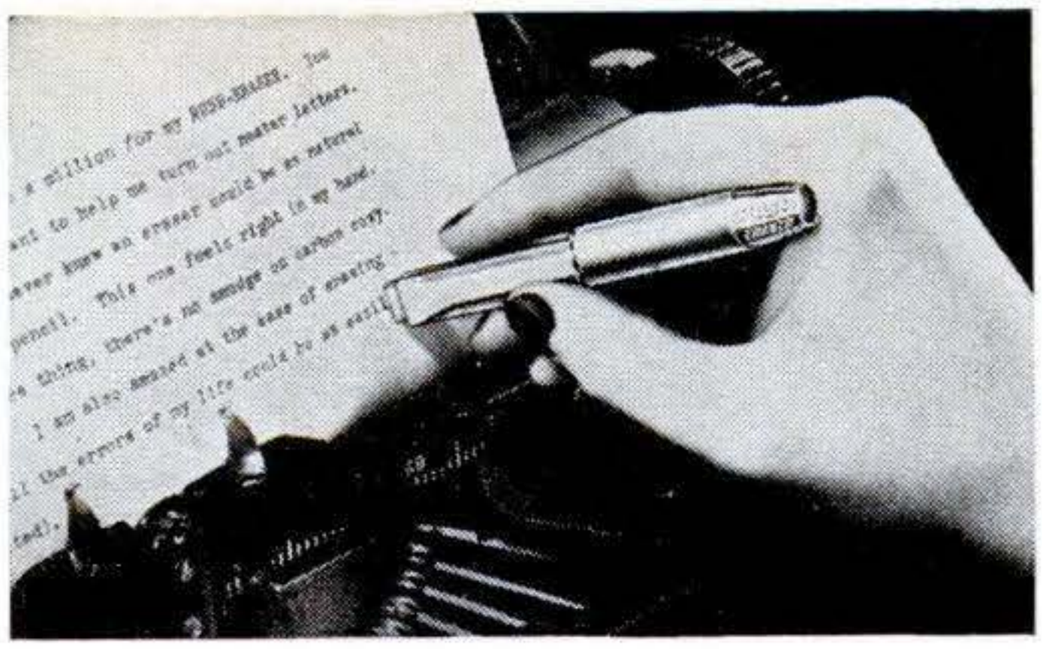
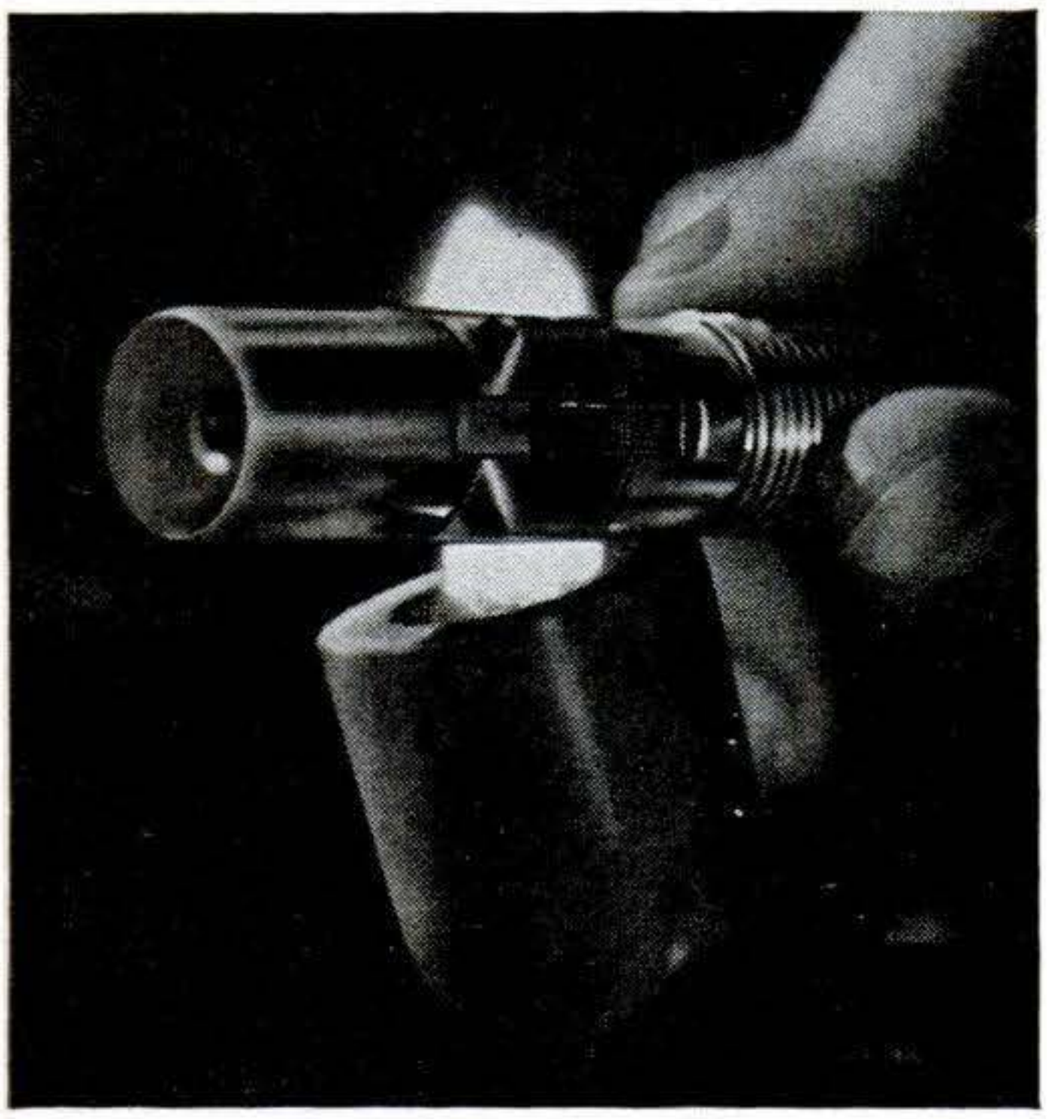
AIDS TO MODERN LIVING

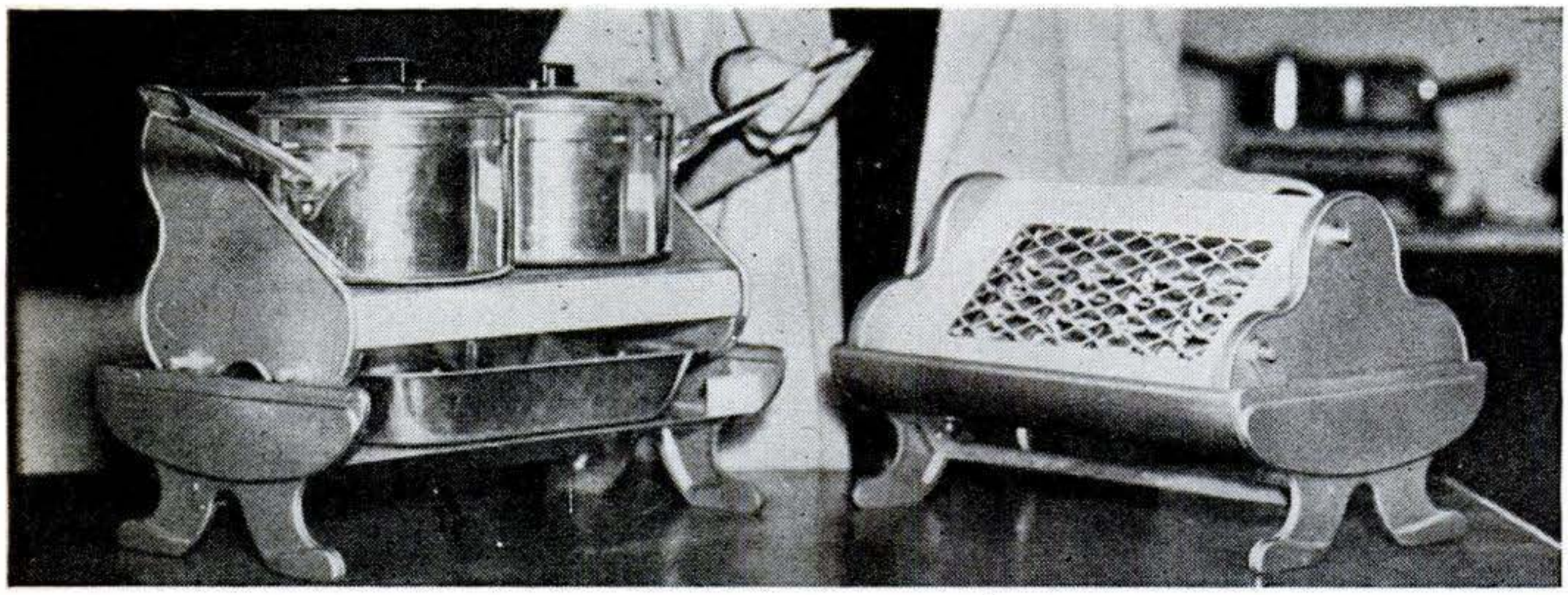


Spun Fibers Erase Cleanly. This eraser will rub away typing mistakes on the top copy without smudging the carbon, and can also be used to correct some kinds of duplicating stencils. It is made by The Eraser Company, Inc., Syracuse, N. Y. Refill cartridges are easily inserted in the plastic, pencil-like holder.



Lighter Burns in the Middle. A pocket lighter for pipe and cigar smokers strikes a flame that burns inside a chimney in the center. When held over a pipe, a strong puff pulls the flame down into the bowl. The recessed position of the wick shields it from the wind. It is sold by Ward-Nimrod Co., of Cincinnati.

Double Shingle. Interlocking shingles, fabricated from felt, asphalt, and mineral granules, overlap in such a way that the roof area is covered by at least two thicknesses at every point. As laid, they resemble a basket weave. The shingles, made by the Ruberoid Co., New York, are intended primarily for new roofing construction, but they can also be used for repairs. They come in several colors.



It Warms You or Your Food. Among the new home appliances being produced in Britain is this double-duty electric heater-cooker. With the top in one position, as at right, it looks and acts like a standard heater. Raising the top converts it into a cooker, as shown at the left. The metal plate on which the pots are resting protects the heating element; the hotplate, in conjunction with the grill below, can handle a complete meal. The device weighs 15 lb., and is supplied in gold and bronze finishes.

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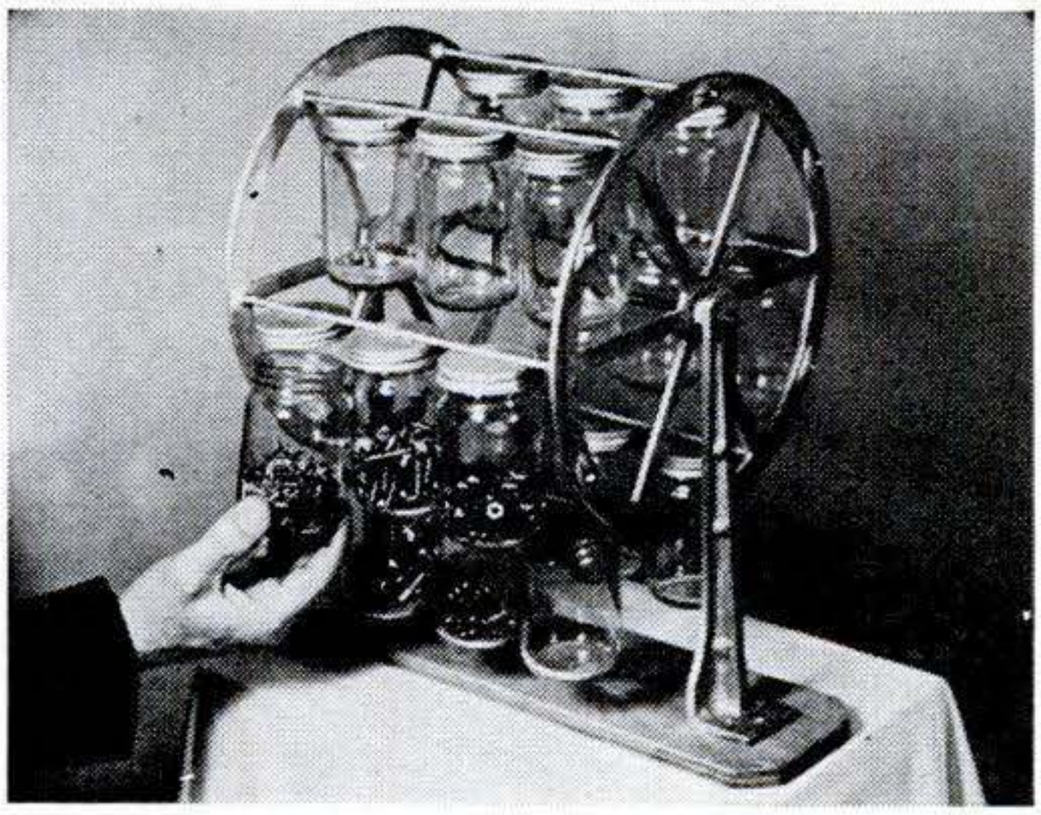
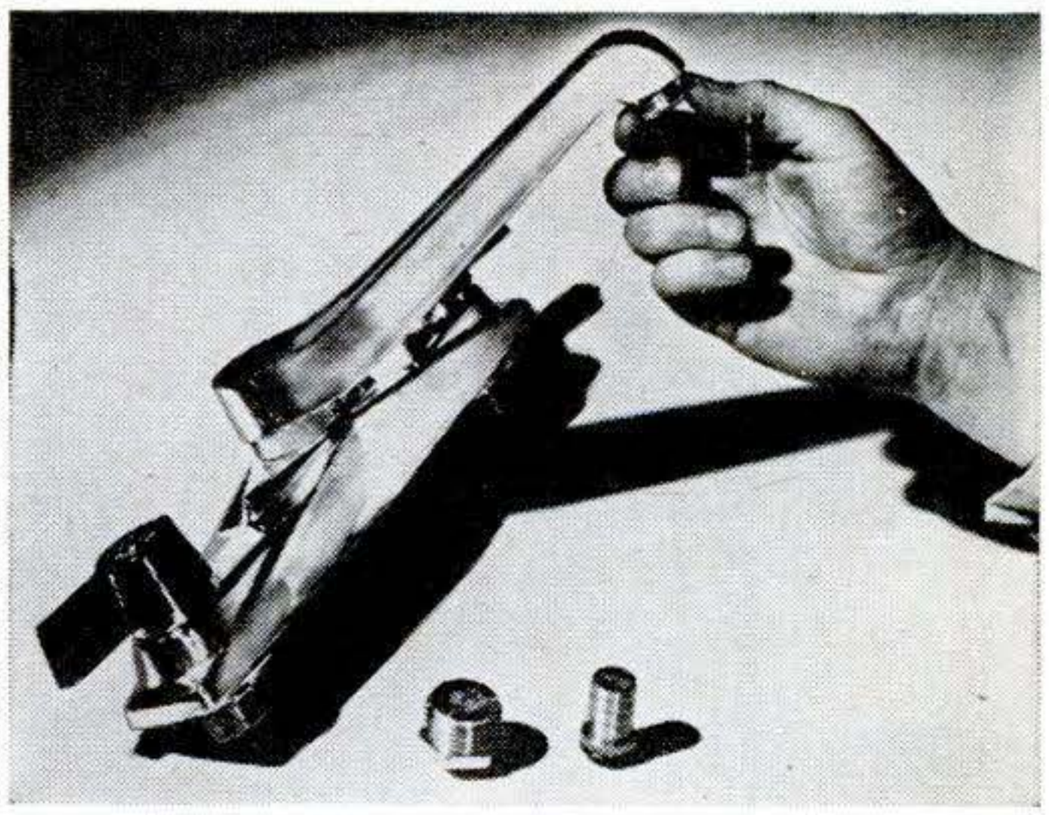
Home Built from Pattern. Complete instructions for building this ranch-style house, or enough of it to live in while the rest is being built, are furnished in pattern form by the Easi-Bild Pattern Company, of Pleasantville, N. Y. The plans sell for $5. and include full-size tracings as well as drawings and photographs.

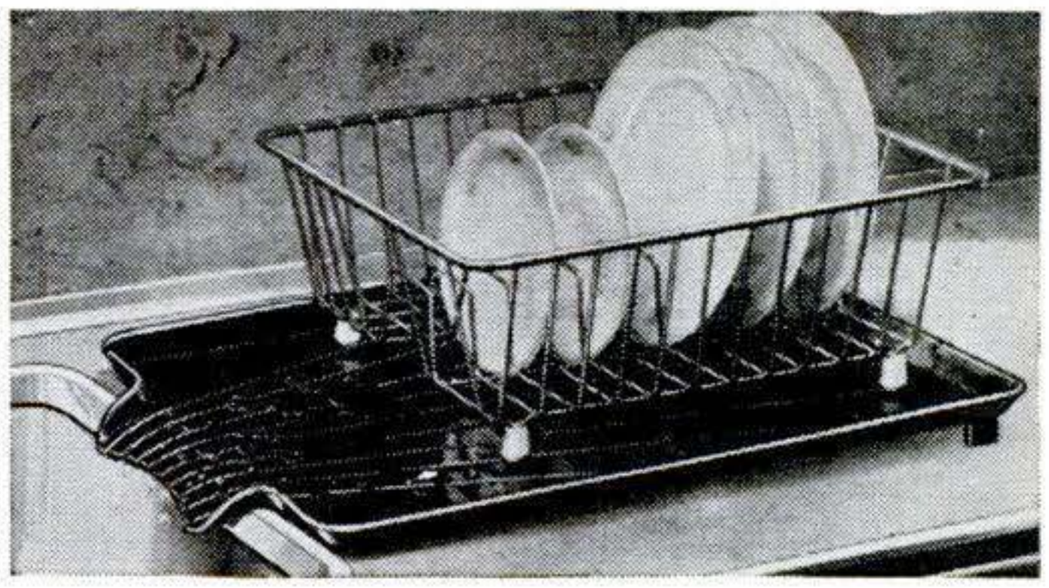


Revolving Shelf. Devised by W. J. Boyle, of San Francisco, the Ferris wheel shelf pictured above holds six rows of 6-oz. bottles. They can be used to store small hardware and parts, or even liquids, since the bottles always remain upright. The holder locks in six positions to permit easy removal of the containers.



Faucet Adaptor Takes Hose. Ordinary garden hose can be used to transfer water from kitchen sink to washtub. Faucets used in cabinet sinks made by Mullins Manufacturing Corporation, Warren, Ohio, take adapters that screw into the spout. One is designed for screw coupling; another permits the hose to be slipped on.

Drainboard Doubles as Tray. Cabinet sinks, increasingly popular in recent years, feature flat working surfaces but do not offer any ready path for excess water to drain back into the sink. For such sinks the Associated Projects Co., Columbus, Ohio, offers a plastic serving tray so designed as to stand level on a flat surface or slope down when its curved lip is placed over the edge of a sink.



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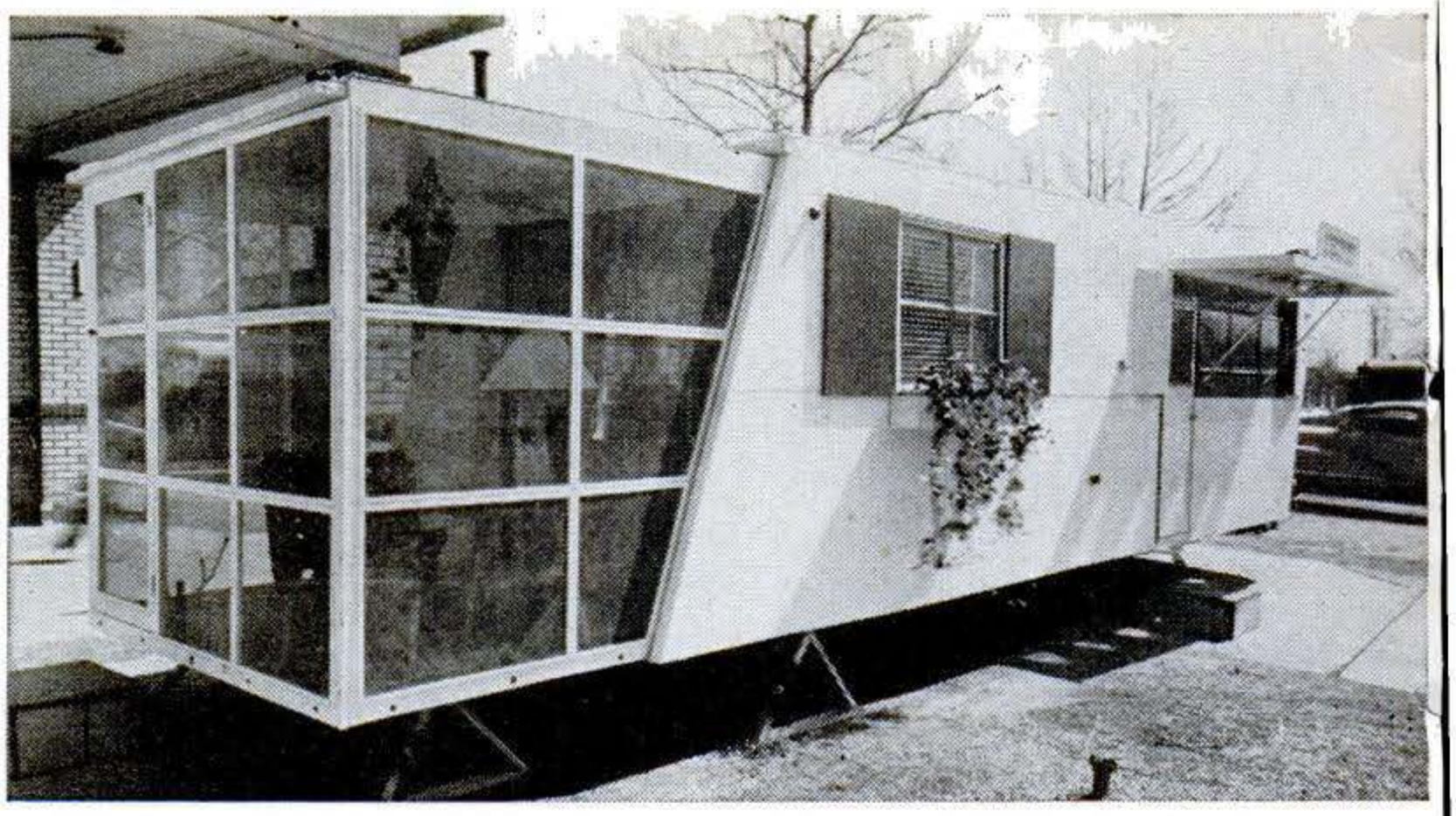
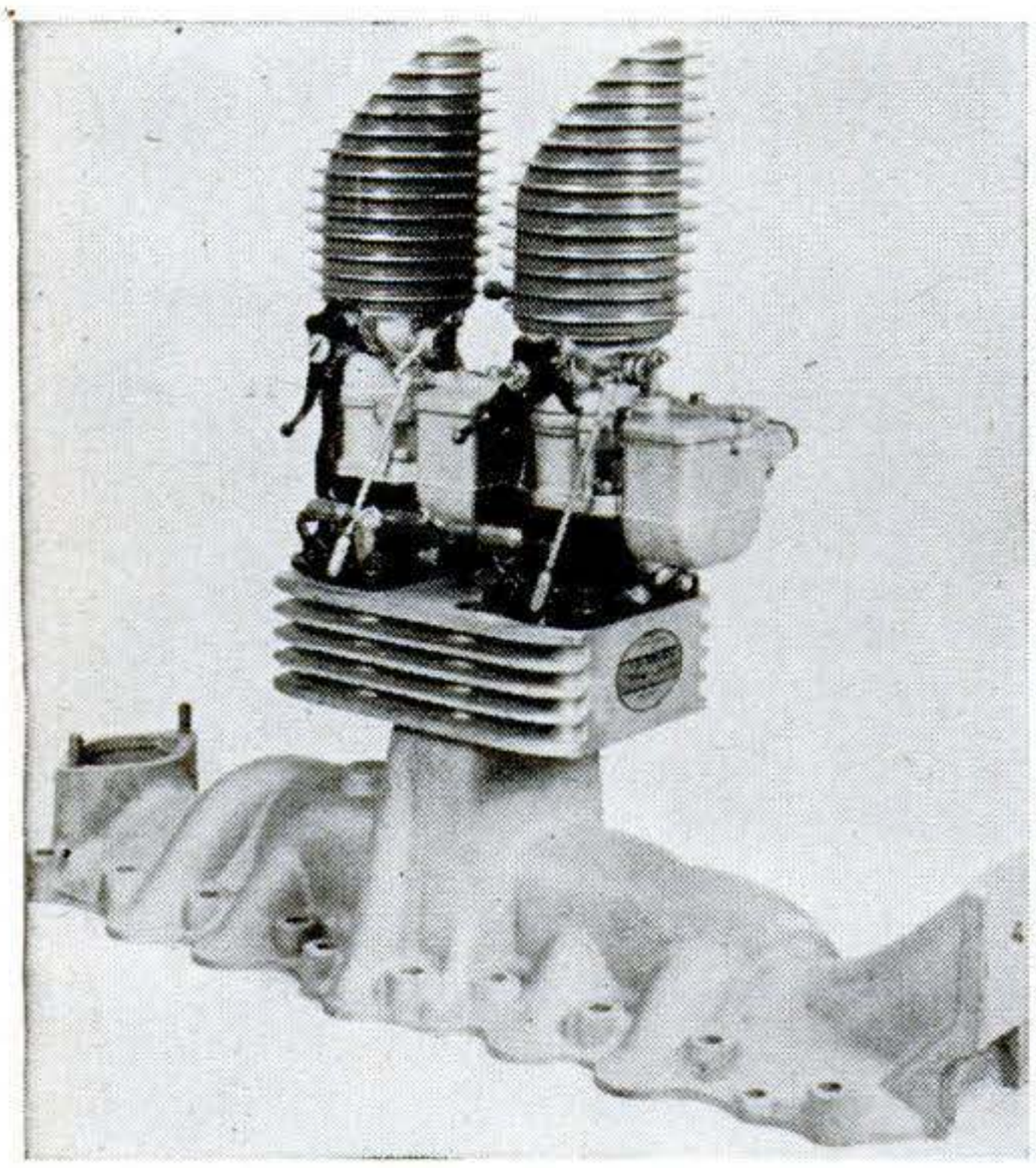
Trailer Has Porch. A trailer built by the Elcar Coach Corporation, of Chicago, Ill., boasts a screen porch in addition to a living-bedroom and kitchen. For traveling, the porch floor swings up against the back, and the screens and furnishings are stored in the triangular space thus formed. The porch floor is 7′ long, but it protrudes only 4′ beyond the body of the trailer. Ready for traveling, the trailer is 28′ 8″ long.



AUTO IDEAS

Heel Rest for Drivers. Formed with a depression to fit the heel, a rubber auto accessory made by Brown Industries, of Chicago, Ill., keeps a driver's right foot in a comfortable positon. It is installed by peeling a protective covering from the adhesive on the underside and pressing it firmly against the floor mat for a few minutes.



Twin Carburetion Provided. A product of the L. B. Backus Manufacturing Co., of Inglewood, Calif., makes it possible to equip a Ford or Chevrolet with two carburetors. Called a "Mani-Adaptor," the unit is mounted on the manifold, the carburetors resting on a finned base and receiving air from twin stacks. Each carburetor supplies half the cylinders, and a stabilizer insures equal carburetion at low and high speeds. The unit is said to increase top speed 20 m.p.h. and cut gas consumption a fifth.

Cartridges Inflate Tire. If a tire goes flat because of a slow leak, an emergency kit marketed by the Kidde Manufacturing Co., Inc., of Bloomfield, N. J., will reinflate it sufficiently to permit driving to a service station. The kit has a dozen cartridges and an attachment that screws on the valve and punctures the cartridge.

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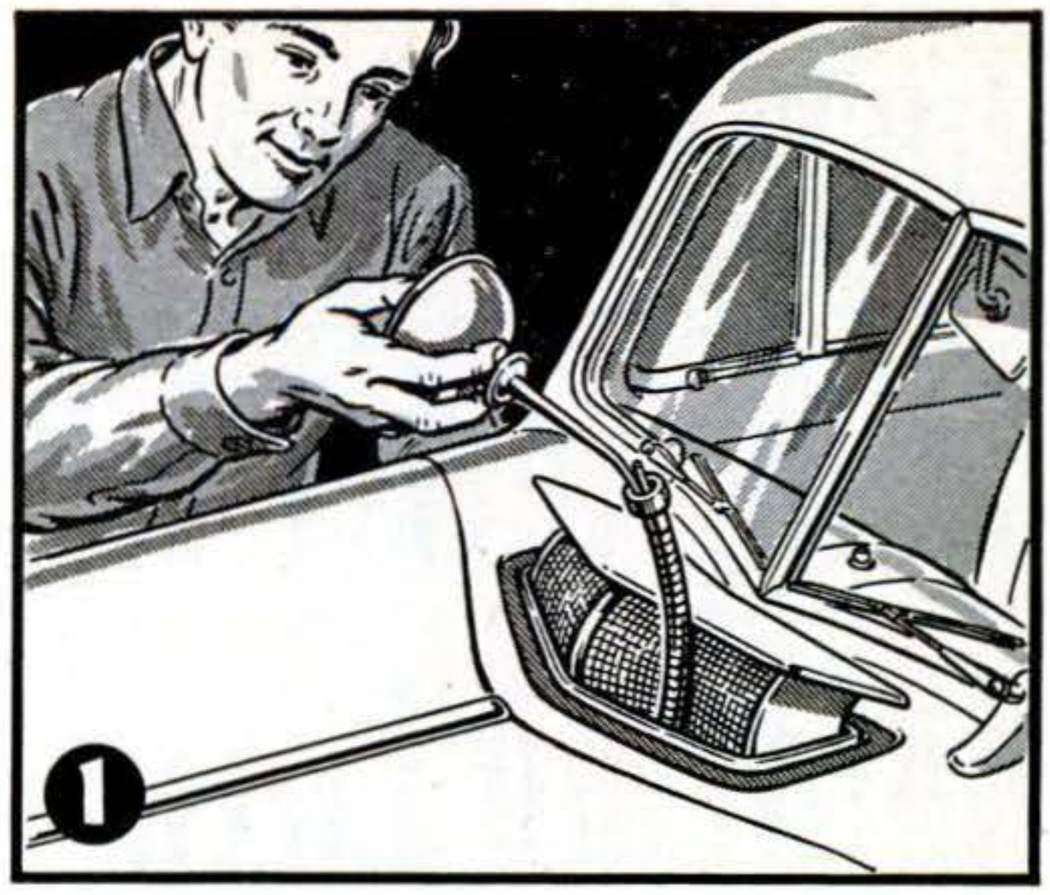
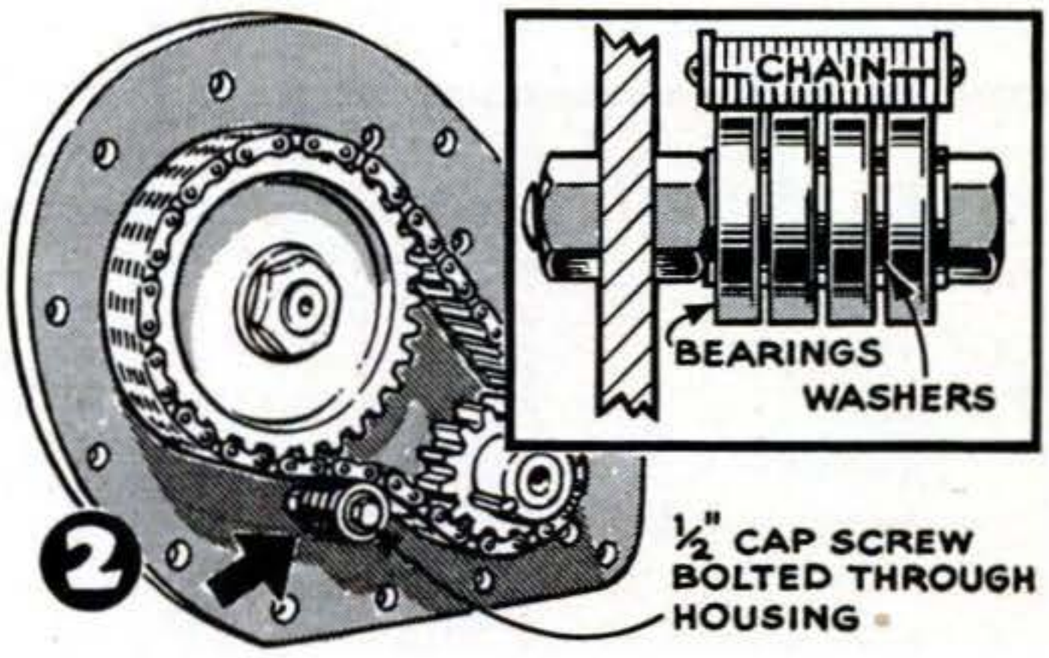
AUTO HINTS

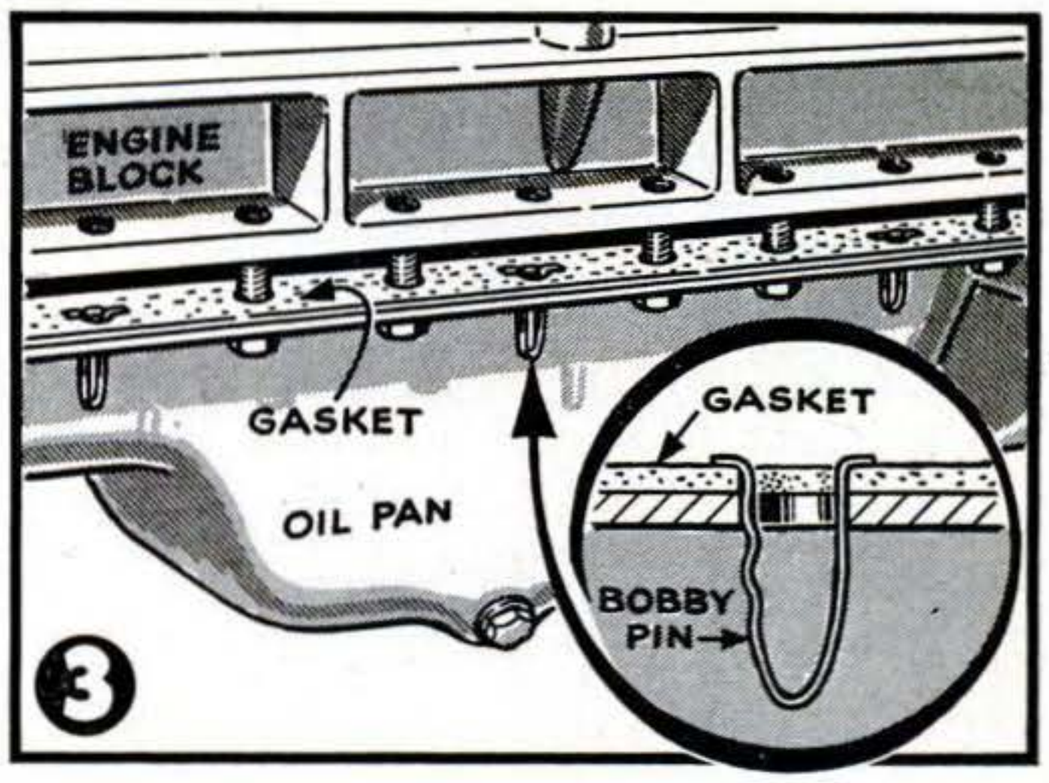
1 Oiling Speedometer Cable. If you find that the inner part of your speedometer cable cannot be drawn out for lubrication, do not risk damage by trying to pull it out forcibly. Instead, bend aside or remove the cowl-ventilator screen and pass the cable through. This will give you ample elevation to oil it.—NORMAN E. NELSON.



2 Takeup for Timing Chain. An idler pulley made from ball bearings on a cap screw will take up a worn timing chain. Clamp the screw to the wall on the slack side of the chain, using two nuts and a lock washer.—F. D. VANVOLKENBURG.

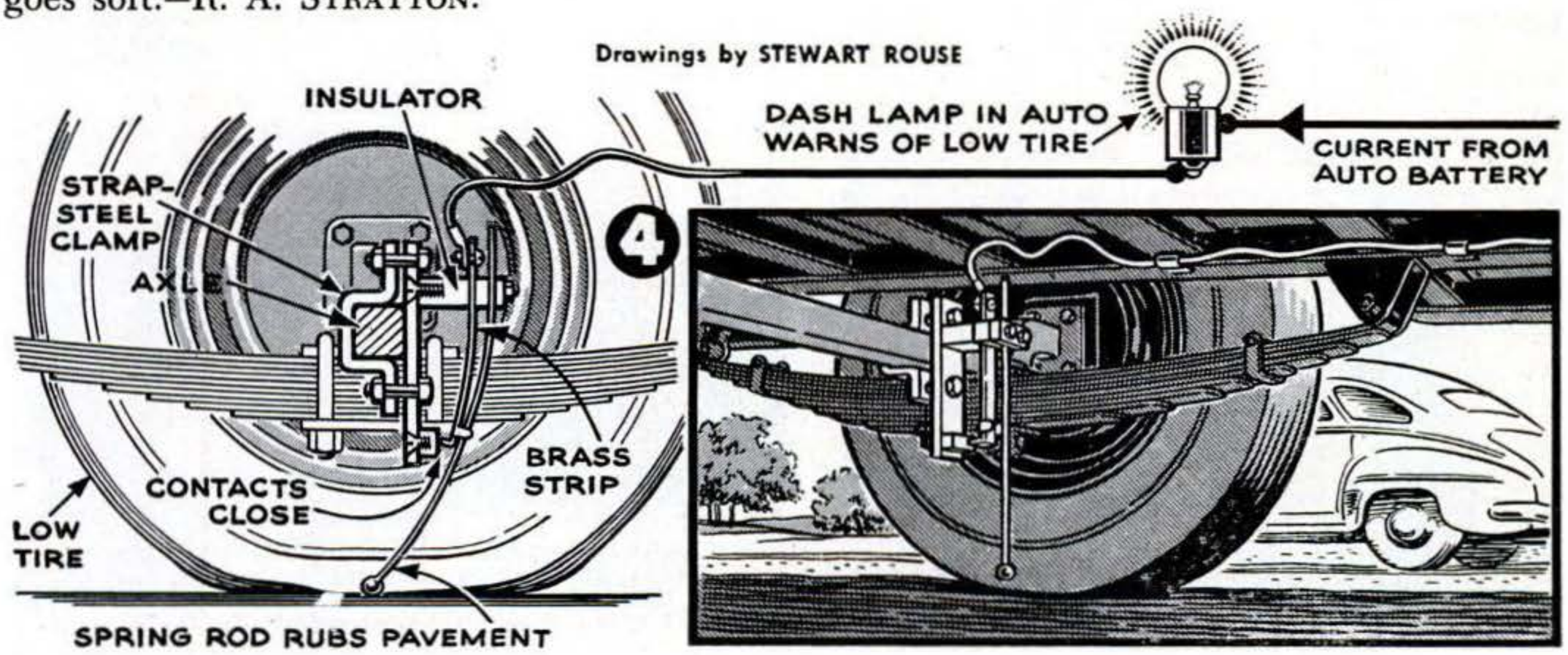


3 Bobby Pins Hold Gasket. A few bobby pins with their ends bent outward at a 90-deg. angle are an excellent means of keeping the gasket in place while an oil pan is being mounted. After several of the studs have been started, pinch the pins together and pull them out of the holes. —LELAND R. HALM.



4 Light Warns of Soft Tire. When a trailer tire goes flat, the car driver may not discover it in time to prevent damage. So I built this warning system on my trailer. A red light signals on the dash if the springy rod, which normally clears the ground by about 1", is bent back as a tire goes soft.—R. A. STRATTON.

Drawings by STEWART ROUSE



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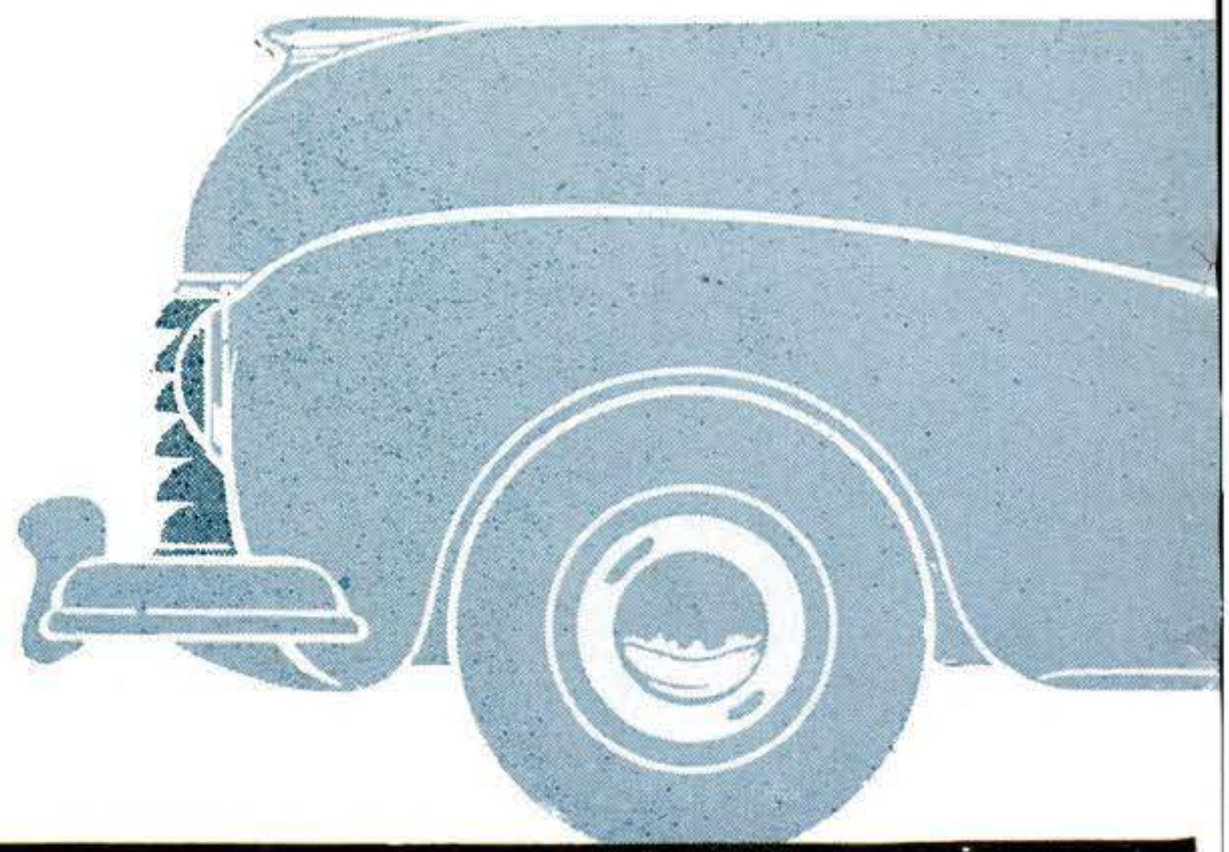
Push Buttons Bring New Motoring Luxury

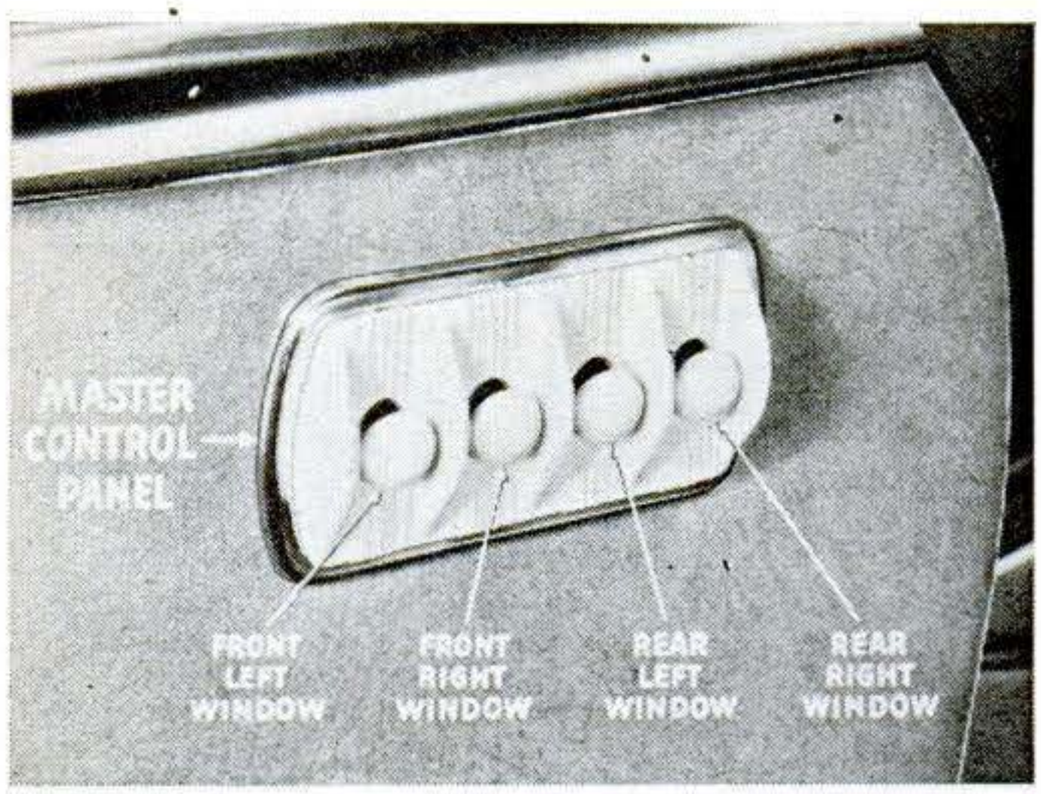


By R. P. Stevenson ***Drawings by Stewart Rouse***

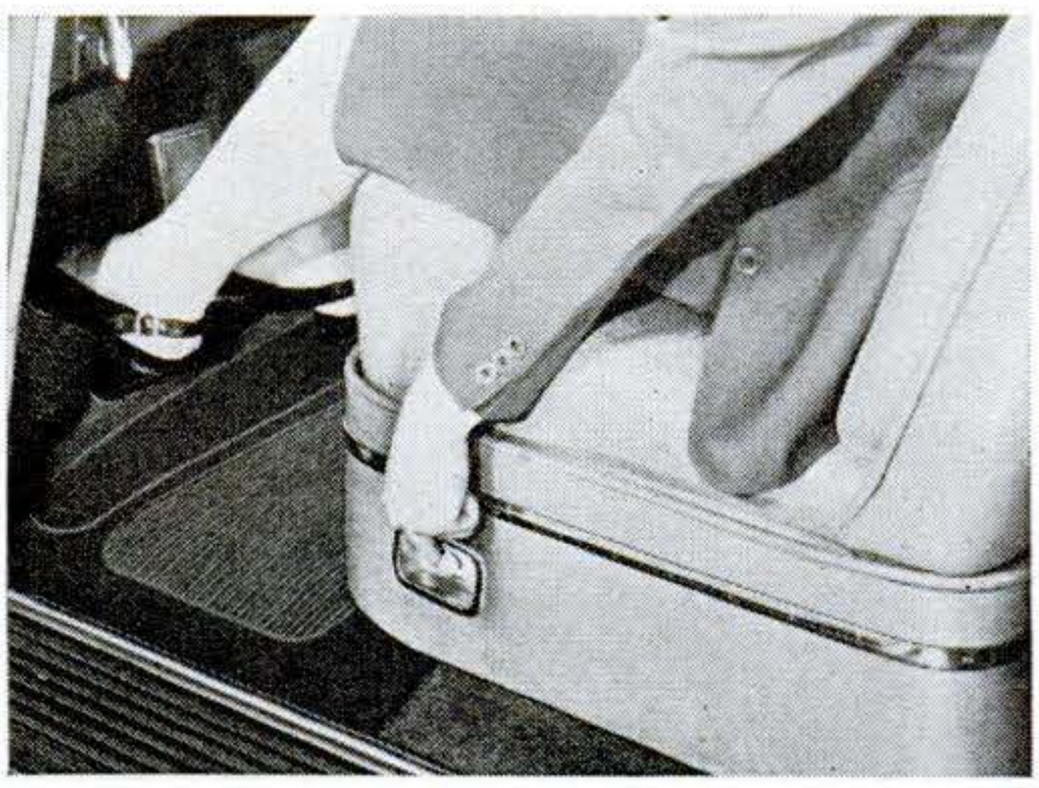
SOME new cars, especially those in the higher price range, are showing up with a surprisingly large crop of push buttons. If you want to raise or lower a window, you touch a button. If you want to adjust the driver's seat, you push another—and slide along to a more comfortable position. If you want to open or close the ventilator wings on the front doors, you touch still another button. And, if the car happens to be a convertible, you generally use the same tactics to raise and lower the top.

Although far from new, application of power to these operations has spread considerably since the war. In early convertibles, the top ordinarily was vacuum operated, although some later ones employed electric motors. But now, engineers apparently have settled upon a hydraulic system as the most practicable.

Such a hydraulic system is manufactured by the Dura Company, of Toledo, Ohio. As illustrated at the top of these pages, power to operate the top, windows, and seat is supplied by a single heavy-duty motor and pump. In addition, the Dura Company has recently added a hydraulic mechanism to open and close the ventilators. Most of the installations so far have been in convertibles, but it seems likely that we shall see an increasing number of hard-top models equipped with automatic windows, ventilators, and seats in the next few years. The Trico Products Corporation, of Buffalo, N. Y., also is in the field with a vacuum system for power operation of the windows



All windows of the 1948 Packard convertible may be operated by buttons on the driver's door. Passenger windows have a single button.



Seat adjustment is controlled with a button located as above. Hydraulic power moves the seat forward; a heavy coil spring returns it.

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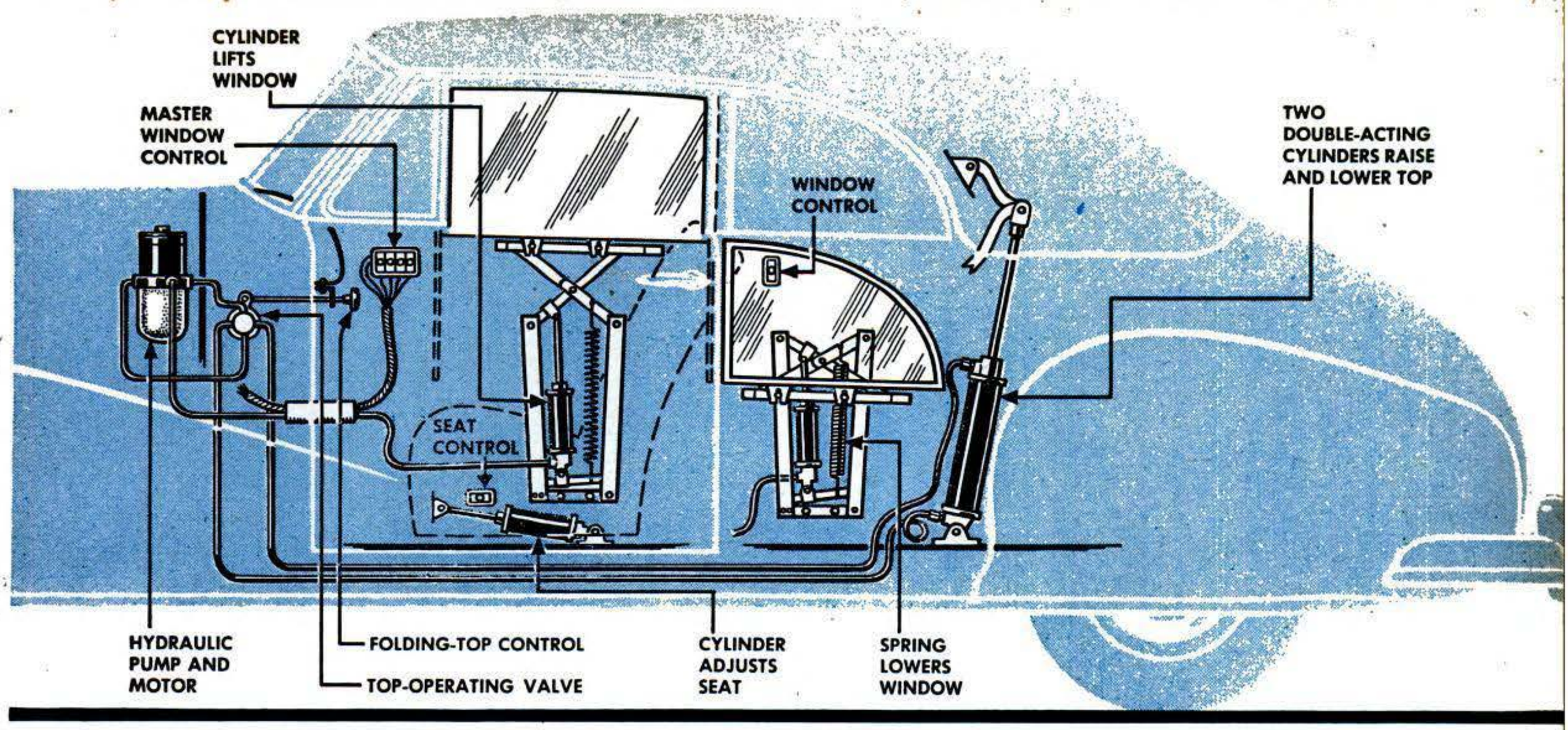
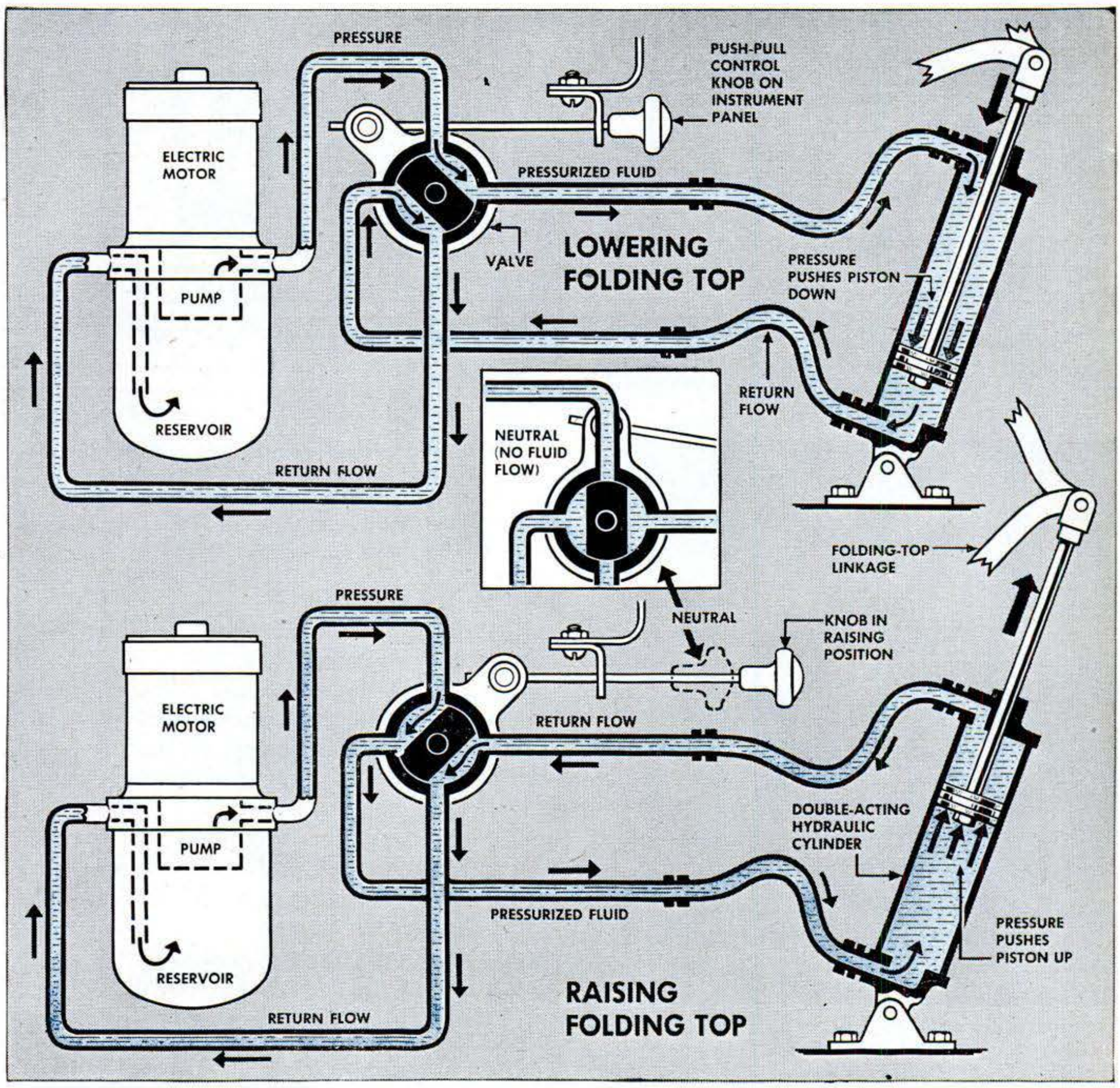


Power operation of the windows and front seat adds a de luxe note to some new cars. In the Dura system, the hydraulic power unit also is used to operate a convertible top, as below.



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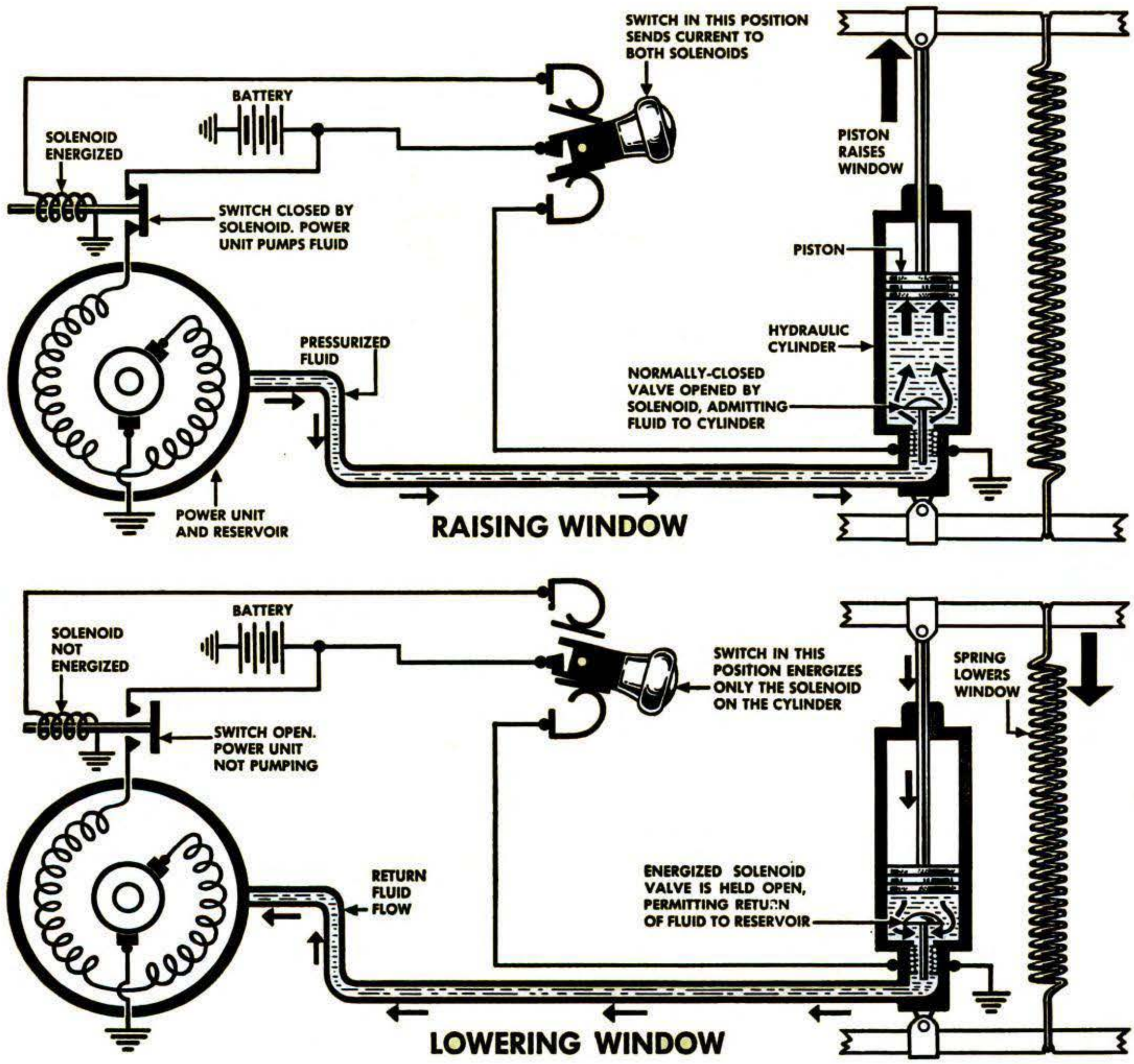

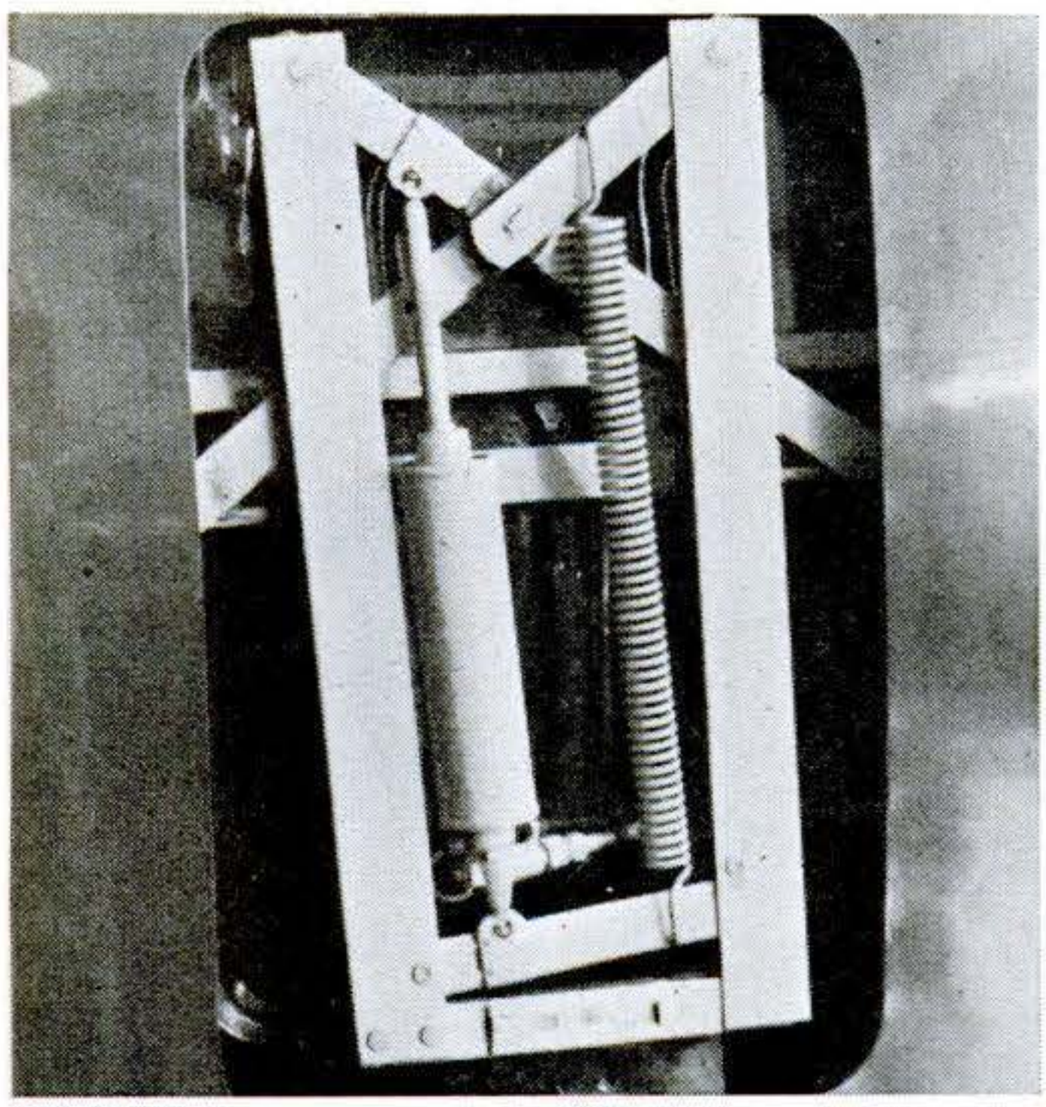

Window glass rests on a lever system connected to a hydraulic power cylinder and return spring.

Single-action cylinders raise the windows in the Dura Hydro-Lectric system. When the switch is at neutral position (not shown above), the valve closes, trapping fluid in the cylinder and keeping the window at any desired height.

and ventilators. This system is illustrated on the facing page.

In the Dura Hydro-Lectric system, a rotor pump develops the pressure needed to operate hydraulic cylinders located at each station. Two double-acting cylinders are employed for a convertible top, while a single-acting cylinder with spring retraction is used for each window, ventilator, and the seat.

When the top is to be raised or lowered, a four-way valve is opened by means of a push-pull knob on the instrument panel. Operation of this knob also turns on the electric motor, and the pressure fluid is directed either to the top or bottom of

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each cylinder, depending on whether the car top is to be raised or lowered. At the same time, fluid from the other end of the cylinder is forced back to the reservoir. In raising and lowering the top, the control knob must be held either out or in throughout the process. When the knob is released, a spring returns the valve to neutral and breaks the electrical connection.

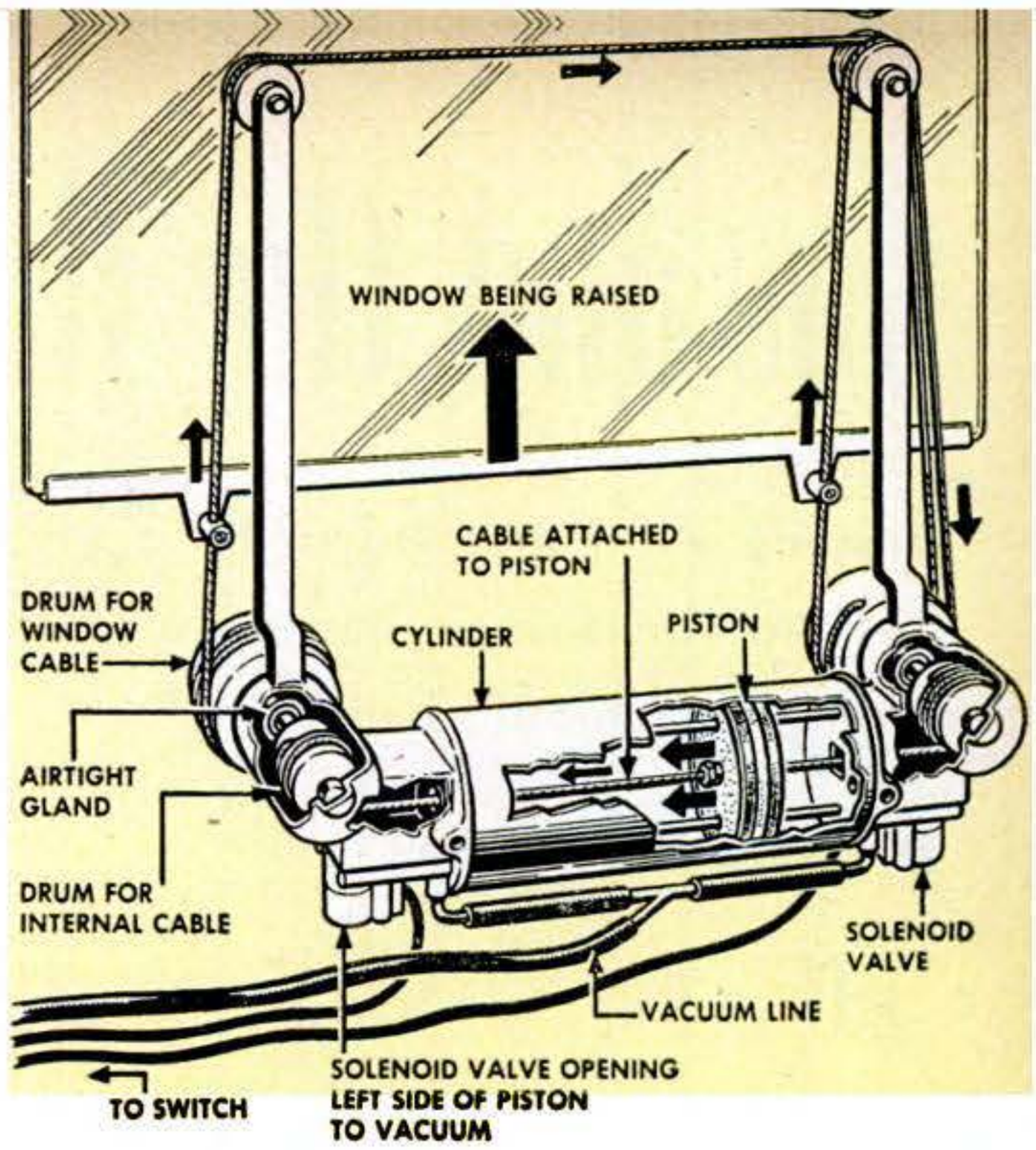
Hydraulic power is used to move the windows, ventilators, and seat in only one direction, springs taking care of movement in the opposite direction. All of these mechanisms function in the same manner as the hydraulic window system illustrated on the facing page. Fluid trapped in the cylinder by a magnetically operated, normally closed valve keeps the window, seat, or ventilator in any desired position. In the case of the windows, there usually is a battery of four buttons within reach of the driver so that he can control any or all of the windows. There also is an individual button at each passenger window.

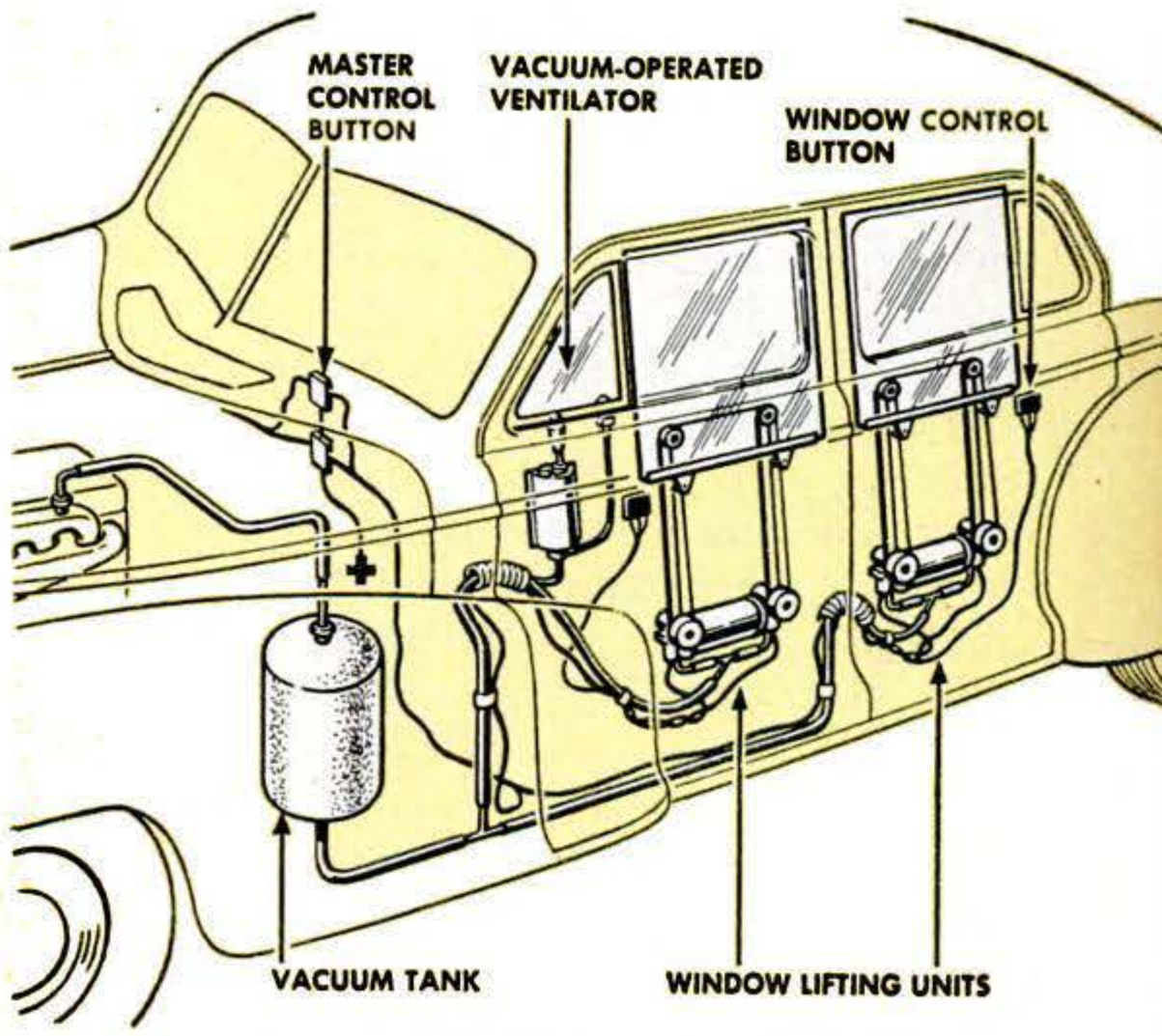
Trico System Is Vacuum Operated

The Trico Products Corporation is producing two vacuum-operated devices for window control—the Lift-O-Matic for raising and lowering the windows, and the Vent-O-Matic for operating the ventilator wings. Both are controlled through electrically actuated valves, suction being provided from a large booster tank through flexible conduits.

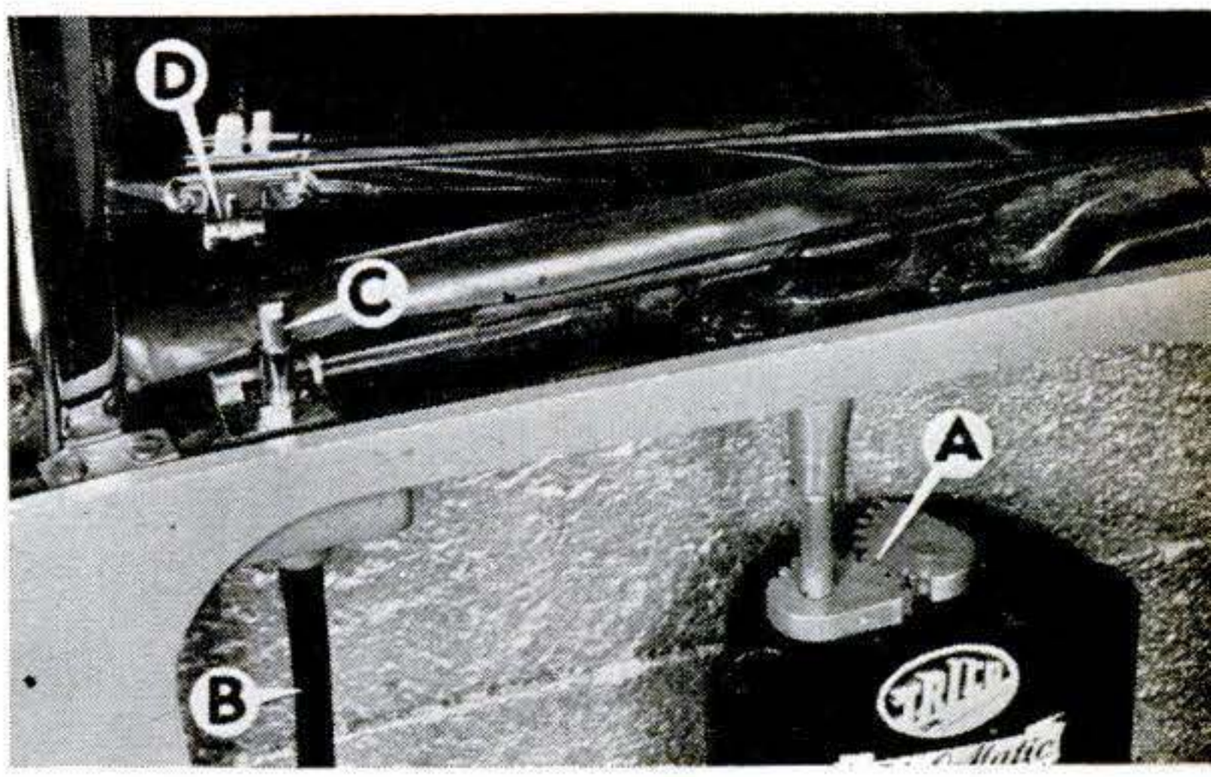
Double-acting cylinders are used in the windows, operation of the switch determining to which side of the piston the vacuum is applied and whether the window is raised or lowered. An internal cable, anchored to a drum at one end of the cylinder, runs into the cylinder, is attached to the piston, and terminates on another drum at the opposite end. Each of these drums is on a common shaft with a larger drum, the latter drums carrying an external cable that is arranged to lift or lower the window—depending on the direction of piston movement. Rubber glands on the drum shafts seal the system.

In the Vent-O-Matic, rotary motion is provided by a vacuum motor, similar to that found in a windshield wiper but larger in size. As seen in the accompanying photo, suction releases the catch at the same time that the motor is set in motion to open the ventilator. This catch snaps shut automatically when the vane closes. END





Vacuum operation of windows and ventilators is provided in a system manufactured by Trico.



To open the ventilator, a vacuum motor turns cogs A, rotating the vane on its shaft. At the same time, suction in hose B depresses the plunger C, allowing catch D to clear it.

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Gus and the Harmonic Pixie

Braving wind and storm on a peace mission, he brings harmony to two screwy "harmonic balancers."

By Martin Bunn

"HEY, boss, take a look!" Stan Hicks called from the door of the Model Garage shop. "This is going to be something."

In spite of the lateness of the season, the day had been still, hot, and sticky, as if a summer thunderstorm were brewing. Gus mopped his perspiring face and went over to the door to look out. The late-afternoon sky had turned the color of tarnished brass overhead, and to the west was a dense, black curtain.

"Boy! Ain't it a—" Stan managed to get out before his voice was drowned in an ear-splitting clap of thunder that trailed away to sullen mutterings. In the dead silence it left, the office telephone rang with jarring sharpness. Then Joe Clark called crisply: "For you, Gus."

Gus went into the office and picked up the instrument. The voice that answered was edged with conscious authority.

"P. X. Jones speaking," it announced. "My car is stalled. Send a competent mechanic immediately. Good-by."

It makes Gus bristle to be ordered around, especially by someone he doesn't know.

"Wait a minute," he replied with some irritation. "Who are you, anyway?"

"P. X. Jones, I told you," the voice repeated pompously. "The person who operates this establishment tells me that you are trustworthy with cars. I must have mine back in running condition at once."

"Where are you?" Gus demanded.

"Just a minute," and the man at the other end of the wire paused. Then his voice came back. "They tell me it's known as Lucy and Bill's. A sort of hamburger joint."

"I know the place," Gus assured him. "When this storm that's coming up is over, I'll be right out to help you."

"Oh, I can't wait." P. X. Jones's voice took on a pleading note. "This is really urgent. I *have* to get down to Washington."

Before Gus could answer, a lurid glare licked the office walls, and another bolt of lightning blasted open the sky. The office phone went completely dead with the roar. Gus stared at the silent receiver.

"Oh, well," he told himself, "it *could* be as important as he says. Anyway I can't do more than get wet."

"Here she comes," Joe said as big raindrops began to spatter the concrete apron at the gas pump. "She's going to be a lulu."

Gus went back to the shop door. "Get your slicker," he told Stan. "There's a car stalled at Lucy and Bill's—a hurry-up job."

He got into the wrecker and drove out of the shop. Stan closed the garage door and climbed in beside him. The wind-driven rain streamed on the windshield faster than the blades of the wipers could clear it off.

Gus switched on the parking lights and drove cautiously through the storm. The highway ahead was a dim, wavering gray ribbon except when the glare of lightning made the wind-bent trees stand out vividly.

It took a full 15 minutes to drive to the roadside eating and juke-box place run by Lucy and Bill, but by the time the wrecker had reached it, the storm was about spent and the western sky was beginning to lighten. The only car in the parking place was an eight-year-old sedan. On the veranda were a pompous, walrus-mustached individual in uniform and a short, sly-faced fellow. The uniform was nothing Gus had ever seen before. It consisted of a brown tunic and dark-green trousers topped by a military cap. An enameled emblem on the cap looked to Gus like a fat pigeon with a sprig in its beak.

As he and Stan walked up in the lessening rain, the short fellow waved airily. "Tell them who you are, Pixie," he suggested to Walrus, who was pacing up and down.

The mustached fellow took something from a wallet and bowed from the waist.

"My card, sir," he said, presenting an oblong pasteboard to Gus. Stan snickered, but Gus managed to keep his face straight as he read: "The National Confederation for International Harmony. P. X. Jones, Grand Harmonic Balancer."

P. X. Jones bowed stiffly again. "At your

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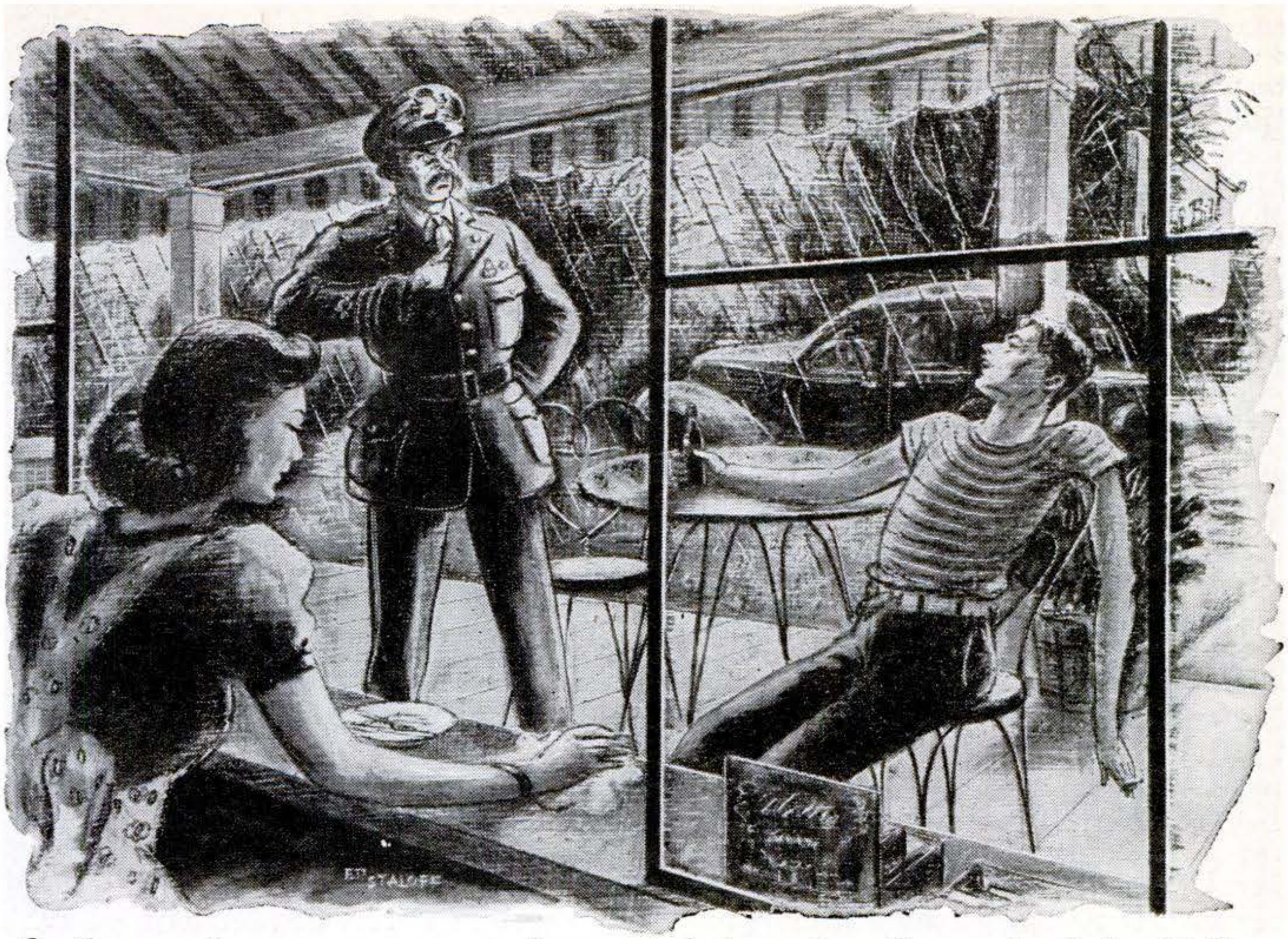

On the veranda were a pompous, walrus-mustached man in uniform and a sly-faced fellow.

service, sir," he said, "and at the service of all suffering humanity."

"Well—er—thanks," Gus muttered uncertainly. "Now, about your car . . ."

P. X. Jones gestured toward the car. "Fix it, my good fellow," he ordered. "It's urgent. Much depends upon my reaching Washington without further delay."

The sly-faced man stopped Jones as he started toward the sedan. "Hold on, Pixie," he said. "You can't afford to get your uniform wet—you gotta wear it tomorrow."

Gus, grinning now in spite of himself, asked: "What's the matter with your car?"

"We stopped here," Jones explained, "on the insistence of Mr. Fundy, my public-relations expert, to get a bite to eat. When we returned to my car—"

Fundy interrupted. "Don't forget to tell him you left the motor running," he prompted. "When we got back it had stalled."

Jones frowned. "My attention," he said, "was on matters of higher importance."

"Then the starter wouldn't turn the motor over," Fundy cut in.

"My first thought," Jones went on, "was that the starter had jammed—that had happened before. I put the car into reverse, and Fundy and I pushed it forward. That freed the motor so the starter would turn it over. But it scraped and squealed."

"Sounded like a couple of tomcats under the hood," Fundy put in. "Scared old Pixie so bad he cut the motor right away."

"I consulted the proprietor of this place," Jones said with dignity. "He thought it was a broken piston or crankshaft trouble and suggested I call you."

"Fix it as fast as you can, will you?" Fundy requested. "We have to get out of Washington early enough tomorrow to get back by evening."

"You won't have much time there," Gus said.

"We don't need much time," Fundy explained. "Anyway, Pixie's a night watchman, and he's got to get back on the job by 6 o'clock. Tonight's his night off."

Jones turned an embarrassed red. "My services to the Confederation," he explained, "bring me no financial return."

"Except your bite out of the annual dues. And when you pass the hat at meetings," Fundy amended.

The Grand Harmonic Balancer let that one go by. "There being no salary attached to my high office," he went on as if he hadn't heard, "it is necessary that I earn my

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living otherwise. I prefer to do it as a night watchman. Then I have ample time to reflect on the tragic state of the world and to formulate plans for its betterment."

Gus's head was beginning to spin. "Well, that's—er—dandy," he said soothingly. "Suppose we try your starter again."

The rain had stopped while they were talking, and they went out to the sedan. Its back seat was occupied by a big camera and tripod. Pixie got in and stepped on the starter. After a couple of attempts, the motor took hold, but from under the hood there came a high-pitched, squealing racket. Pixie cut the ignition quickly.

Gus lifted the hood, and his eye first caught the combined pulley and harmonic-balancer unit mounted under the fan.

"Wonder if Pixie took his high-sounding title from that," he thought, "or if he even knows there's such a thing on his car."

He had Pixie start up again, and the motor ran with the same squealing noise, but this time it appeared to Gus to be coming from the harmonic-balancer unit. "Let her idle," he told Pixie and watched as, after a few revolutions, the engine stalled.

Gus felt the fan belt and inspected the generator closely. Grinning, he took the aluminum cover off the balancer unit. A small bolt dropped down on the drip pan.

"Get me a wrench, Stan," he called to the Model Garage grease monkey. Then he replaced the bolt under the generator, tightened it, and put back the cover of the balancer unit. "Now try it," he told Pixie. The motor took off promptly and ran smoothly.

GUS and Stan watched the sedan drive away. "I wonder what Pixie's doing in Washington that's so important," Gus said.

"Oh, I found that out—I asked Fundy," Stan laughed. "He's going down to have his picture taken—wants it on the steps of the Capitol, with the dome in the background, so he can use it on posters to advertise his racket, Fundy says."

"Well, of all the . . . " Gus exploded. "So that's why we took a wetting!"

"Fundy says he isn't sure if Pixie is a grafter or a nut," Stan went on. "But he's getting paid thirty bucks for the picture-taking job. Say, Boss, what *was* the matter with that bus? You just looked under the hood and located the trouble right away."

"I didn't just look at the engine—I listened to it, too," Gus reminded him. "Do you know what a harmonic balancer is?"

"Get your slicker," he told Stan. "There's a car stalled at Lucy and Bill's—a hurry-up job."

"Why, sure I do," Stan said. "Pixie's one."

"They have them on cars, too," Gus grinned. "It's a gadget to neutralize torsional vibration of the crankshaft."

"Was that the thing you took the cover off of when the bolt fell out?" Stan asked.

Gus nodded.

"But how did you know a bolt was jammed in it?" Stan persisted.

"It sounded to me as if the noise came from the balancer unit. I noticed that the fan belt was slack, and when I felt the generator, it was loose on its mounting and a little out of place. Then I checked it and found the bolt that holds it at its swivel point was missing."

"Oh," Stan said. "So you figured the bolt had fallen into the—harmonic balancer."

"That was the tip-off," Gus went on. "If the bolt had slipped down and got wedged between the balancer and its cover, it might not actually lock the motor, but it could jam it hard enough to stall it when it was left idling and make that racket when it was turning over faster. That was really what happened. When I took the balancer cover off, the bolt fell out. All that was left was to put it back in the right place."

"So with one harmonic balancer back in working order," Stan grinned, "the other could go on harmonizing—and getting his picture taken."

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MECHANICS AND HANDICRAFT

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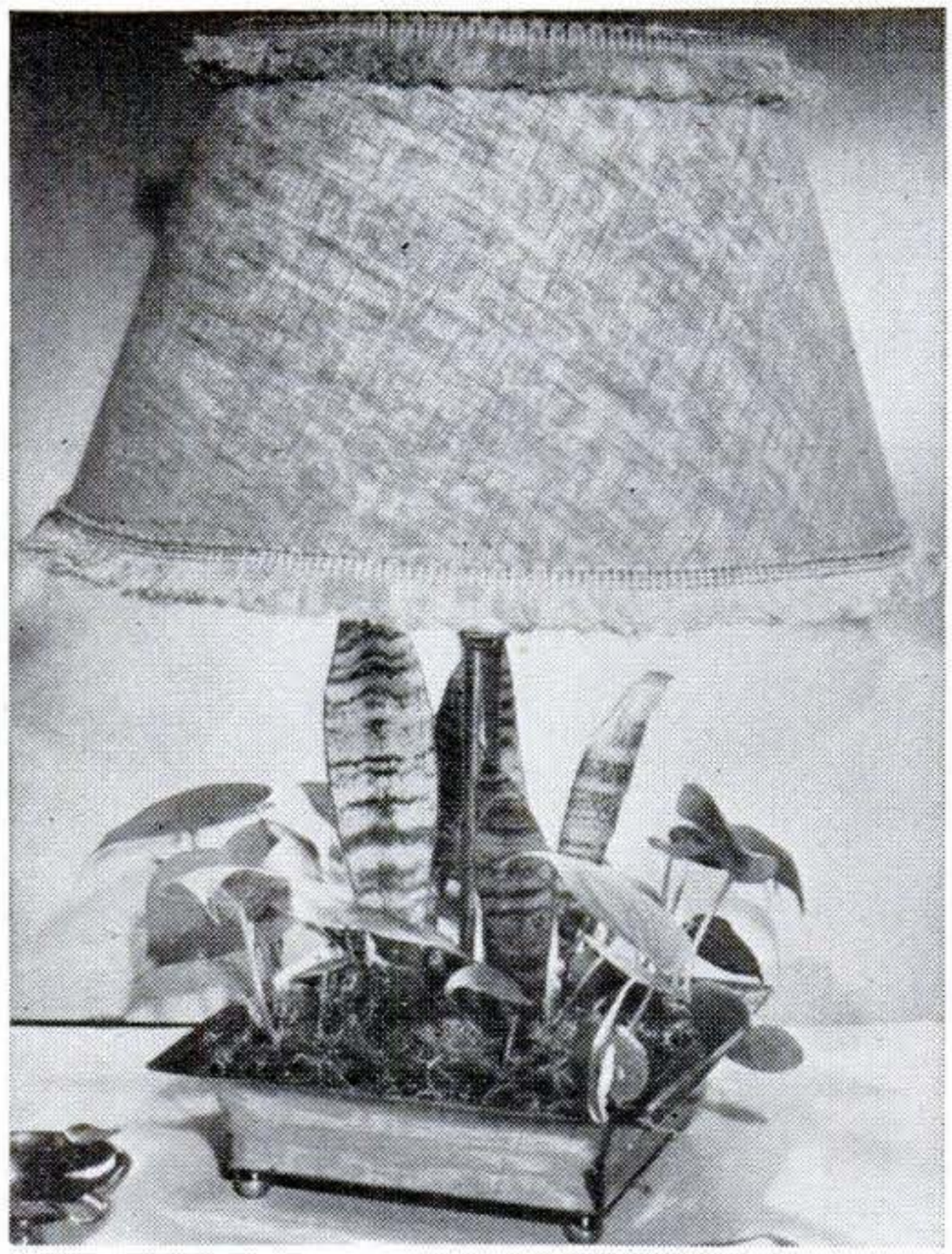
Copper Lamp Is Table Garden

Handsome sheet-metal project combines appeal of growing greenery with soft illumination.

By Bill Luther



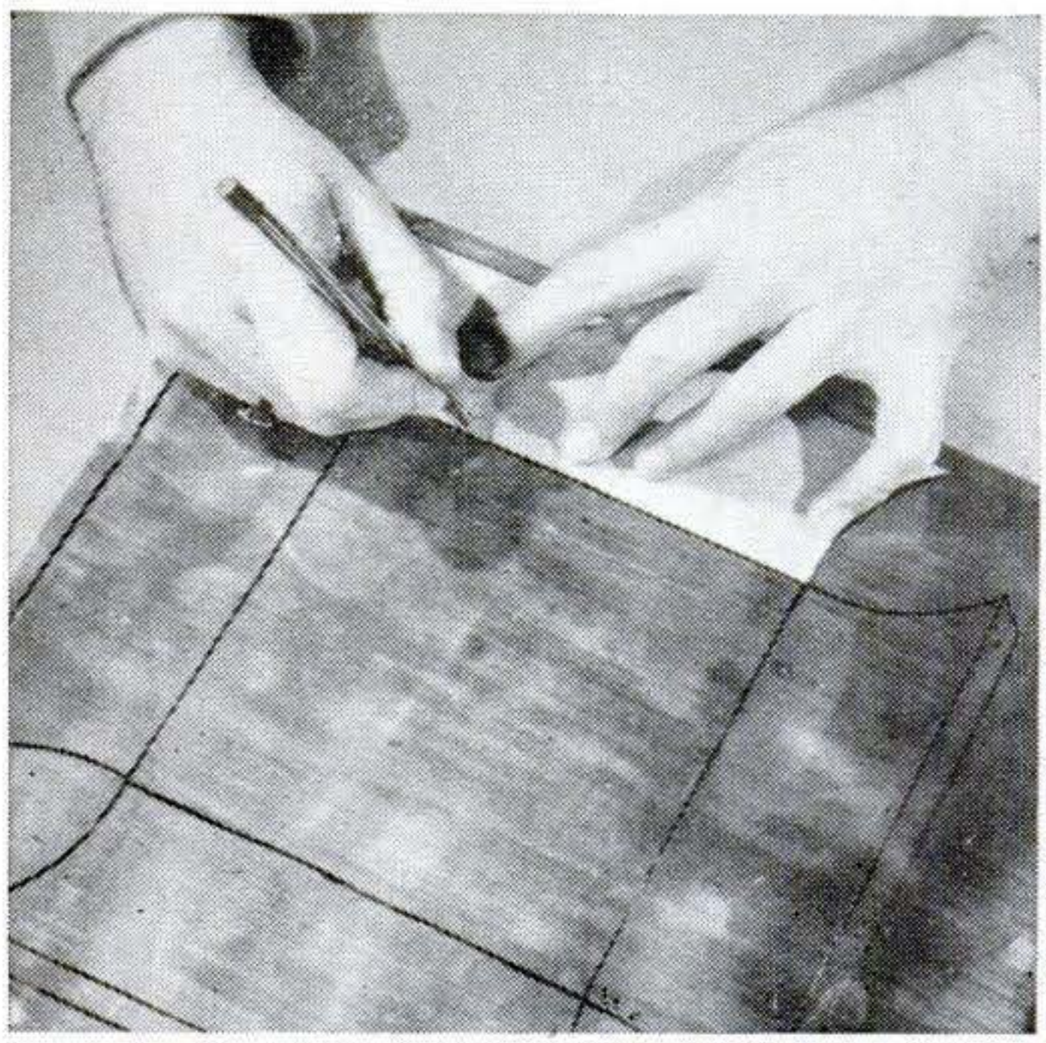
The shade, purchased or homemade, should be about 14″ at its largest diameter, 8½″ high. This lamp is shown in full color on page 136.

CURRENTLY enjoying great popularity as a decorator's item, copper or brass "planter's lamps" add a pleasing touch to any room. Here is one such lamp that may be fashioned with hand tools.

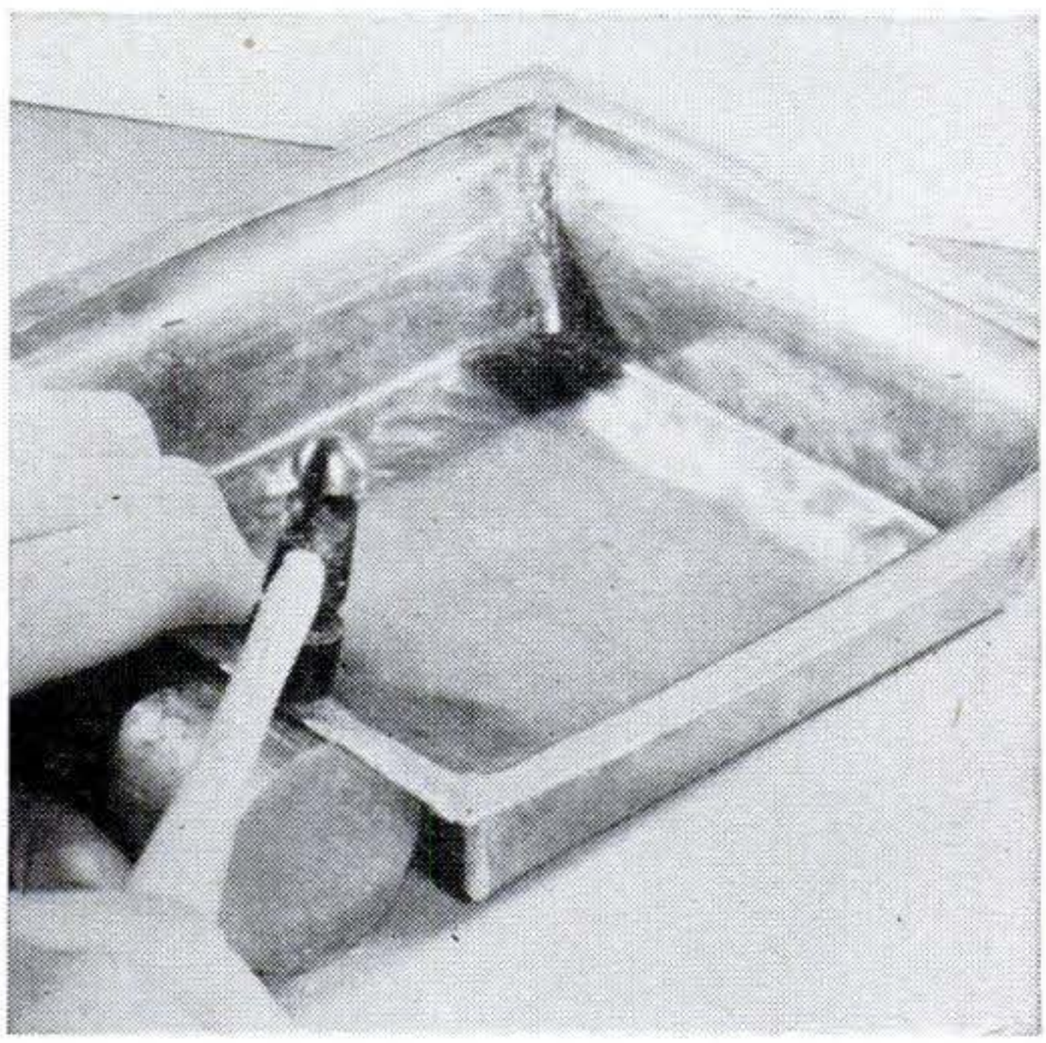
Start by laying out a full-sized cardboard template of one side of the lamp from the squared pattern. On soft 16-oz. copper draw a 6″ square. Then lay the template successively along the four sides and trace around it, marking the two ends of the fold line each time. Snip out the metal, clamp wood blocks along the fold line, and turn up the stiffening flaps.

Clamp a 6″ square wood block inside the guide lines. Then, using a wood strip as a hammering block, bend the sides at 90 deg. to the bottom. A length of 2″ round stock or pipe is next used to form the curvature of the sidepieces, and to hammer the stiffening folds smooth and flat.

In fitting the sides, it is important to get good, watertight joints. Grind or file the



Draw a 6″ square on a sheet of copper, trace off the template which serves for all four sides, and snip out the copper blank. Fold the flaps up to form stiff edges.



Rod or pipe of 2″ diameter provides a form for rounding the upper part of the sides. A soft mallet is used for the shaping, a hammer for crimping the stiffening flap sharply.

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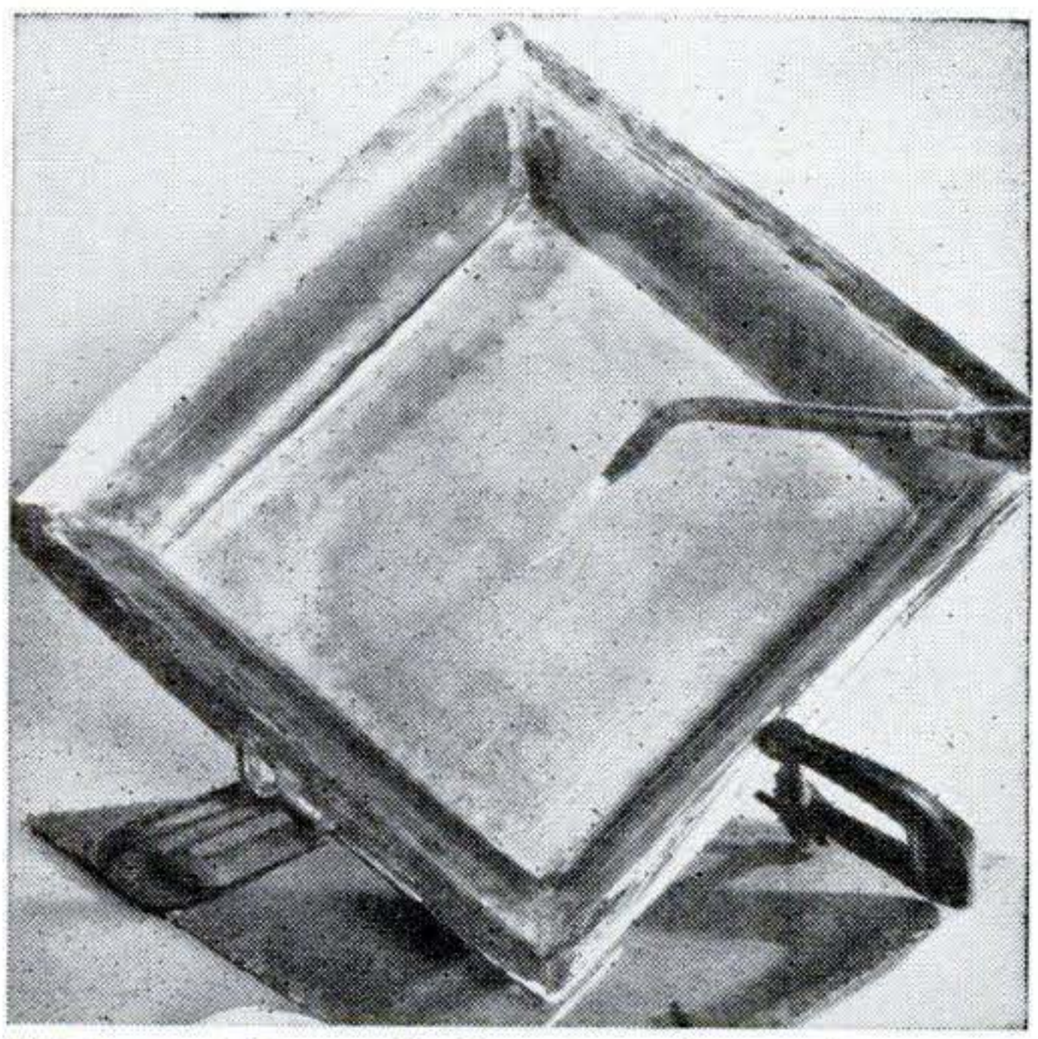
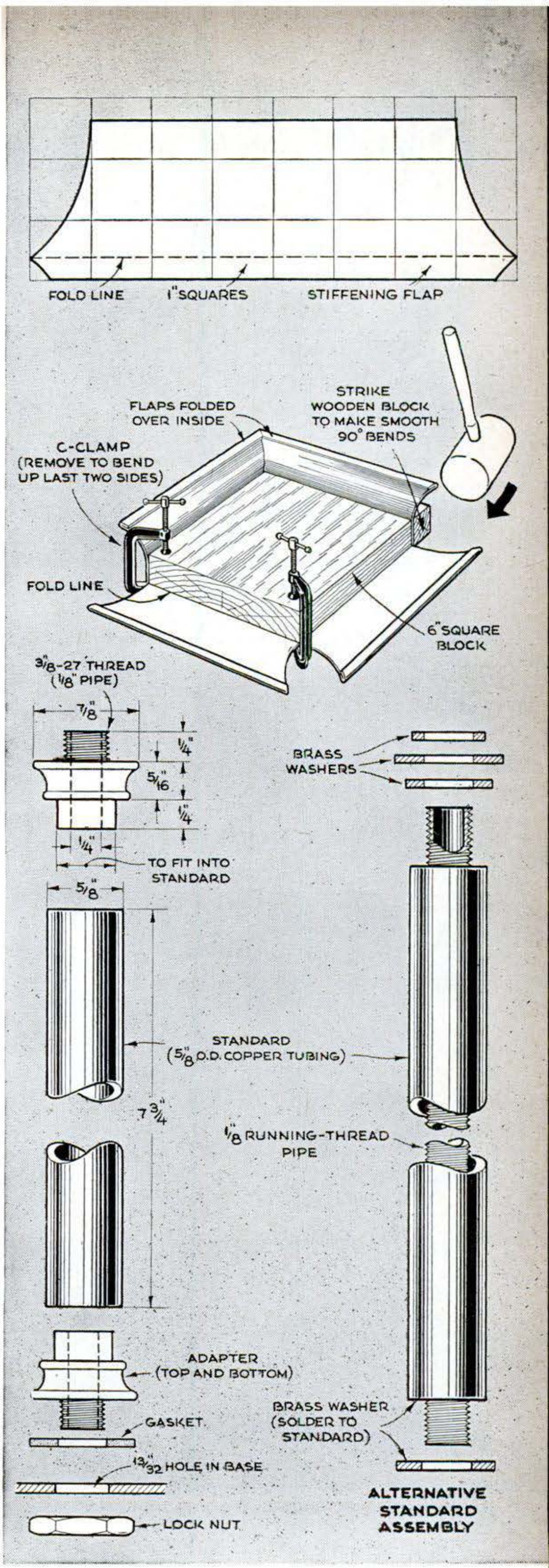
edges lightly until they fit smoothly; then fashion a right-angle bracket from sheet metal or heavy wire and clamp it to the work at both sides of the corner joint. Tip the work and flow soft solder into the corner. Copper conducts heat away very rapidly, so a torch or heavy iron will be needed. Repeat for all four corners, test for watertightness, and clean off the excess solder with a half-round file or hand grinder and rubber abrasive wheel.

Drill a 13/32″ hole in the center of the pan, flatten the metal around it, and file off any burrs. The upright standard may be made from a piece of ⅝″ O.D. copper tubing and turned adapters threaded ⅜″-27 and sweated into the tube. If no lathe is available, an alternative assembly built up with gilded washers may be used. You can turn the feet, or simply solder on ball-shaped lamp finials.

Buff all parts, or satin-finish the project with steel wool. Wipe off grease and oil with a rag dipped in lacquer thinner, and then brush or spray on a thin mixture of clear lacquer. Run some of it over both sides of the heavy-paper gasket that is used between the nipple on the lower end of the standard and the base, and tighten the lock nut to hold the assembly in place. Wiring of the socket—preferably with gold-colored cord—and installation of a shade harp complete the project. Sturdy plants that do not have very deep roots or require great quantities of water will thrive best.



With a right-angle bracket clamped securely to the sides, tip the work and flow soft solder into the corners. A torch is preferable, but a large soldering iron will also serve.



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Turn Out This "Silent Butler"

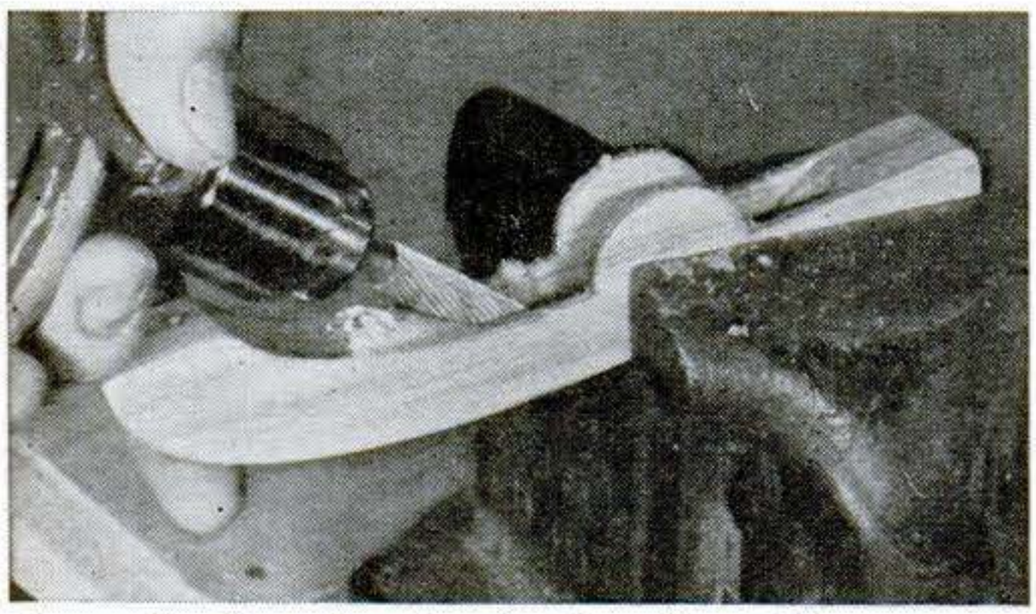
Lever action lifts the cover, allowing plenty of space to remove the hammered metal liner.

FOR a careful craftsman, here's a job that really fills the bill—a "silent butler" made from contrasting woods and fitted with a copper or aluminum tray.

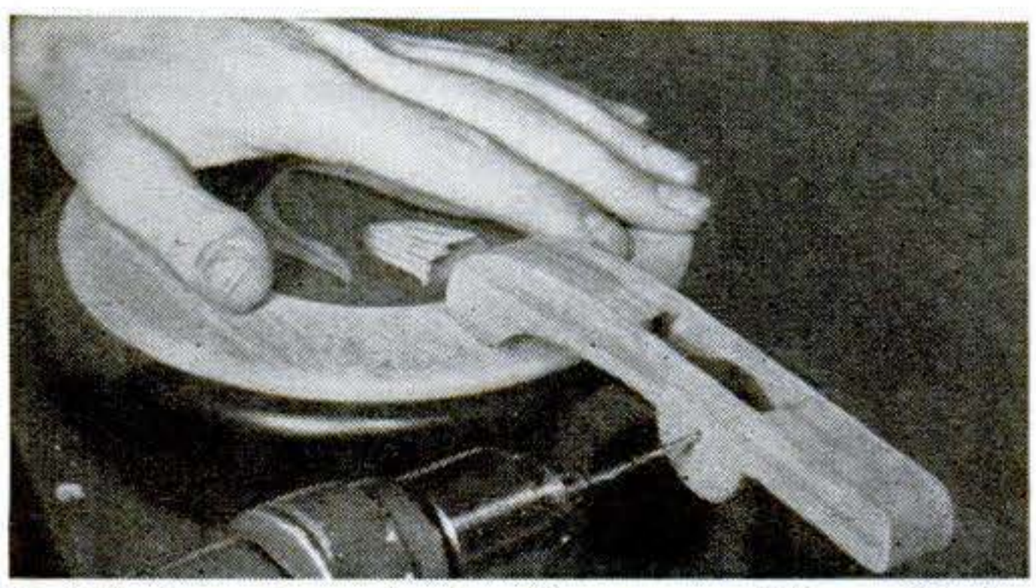
Start with a block of walnut 2″ by 8″ by 8″, attaching it to the lathe faceplate to hollow the bowl and reversing to hollow the underside. If you intend to hammer a tray, turn the bottom of the inside of the bowl to a ½″ radius. If you prefer a tray made up of two soldered pieces, substitute a sharp corner as indicated. A form block the size of the inside of the bowl, minus twice the thickness of the metal, may be used to hammer the tray. By working carefully, you could even use the bowl itself as a form. This should be done before the base has been hollowed.

Jigsaw the cover and the main part of the handle from maple and the handle brace from walnut. If you don't care to tackle the inlay on the cover, a ready-made one can be purchased that need only be glued in place and sanded flush. A copper disk with an engraved monogram might also be used.

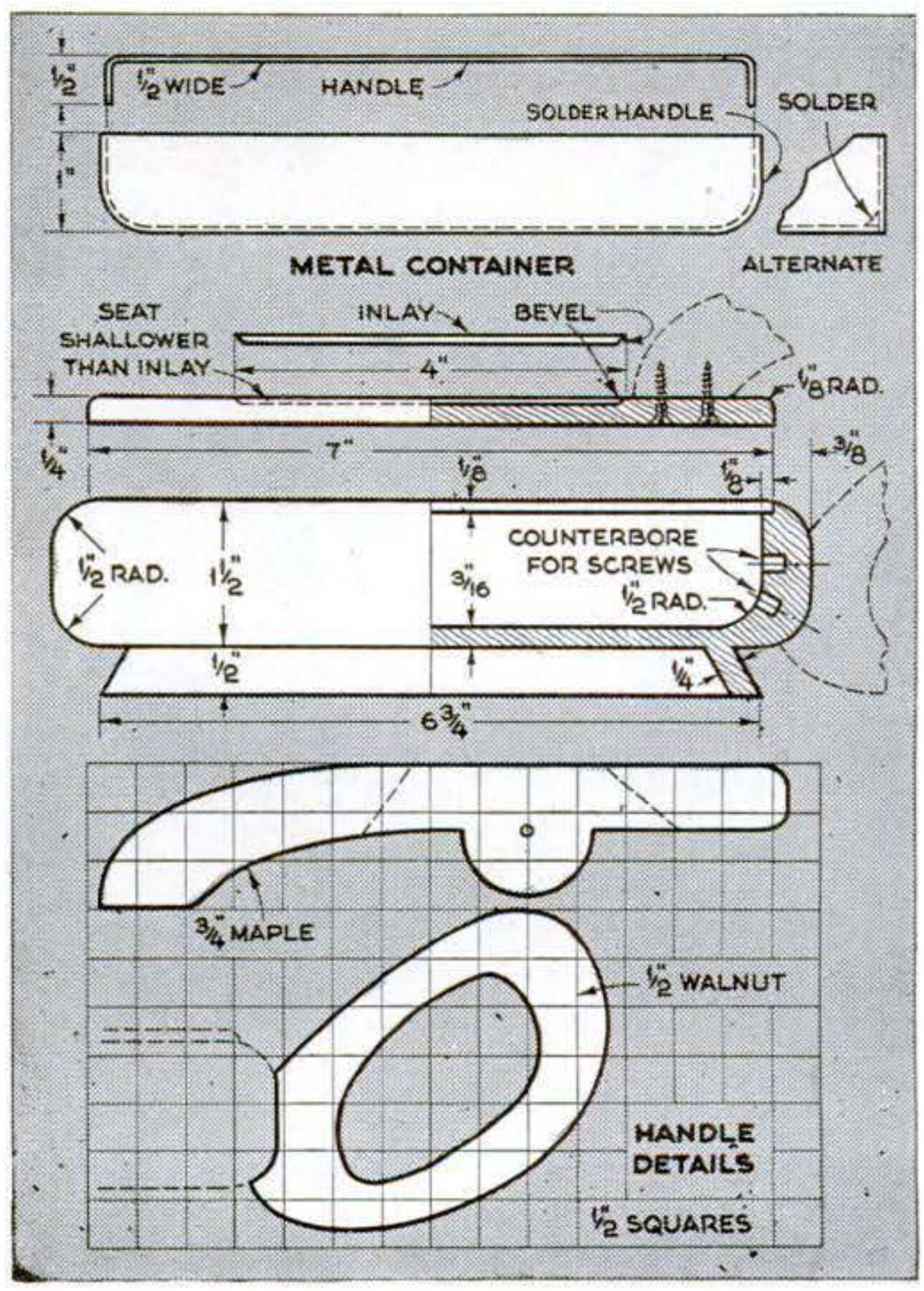
Cut a diagonal slot through the handle as indicated by the dotted lines on the pattern, making certain there is ample clearance for easy action. Sand all parts well, assemble with screws, and drill the pivot hole for the handle. Finish the wood parts according to preference.—R. J. De Cristoforo.



Smooth the slot in the handle with a rotary file or reamer. Provide adequate clearance.



Drill the pivot hole after assembling all the parts, using care to get it perfectly square.



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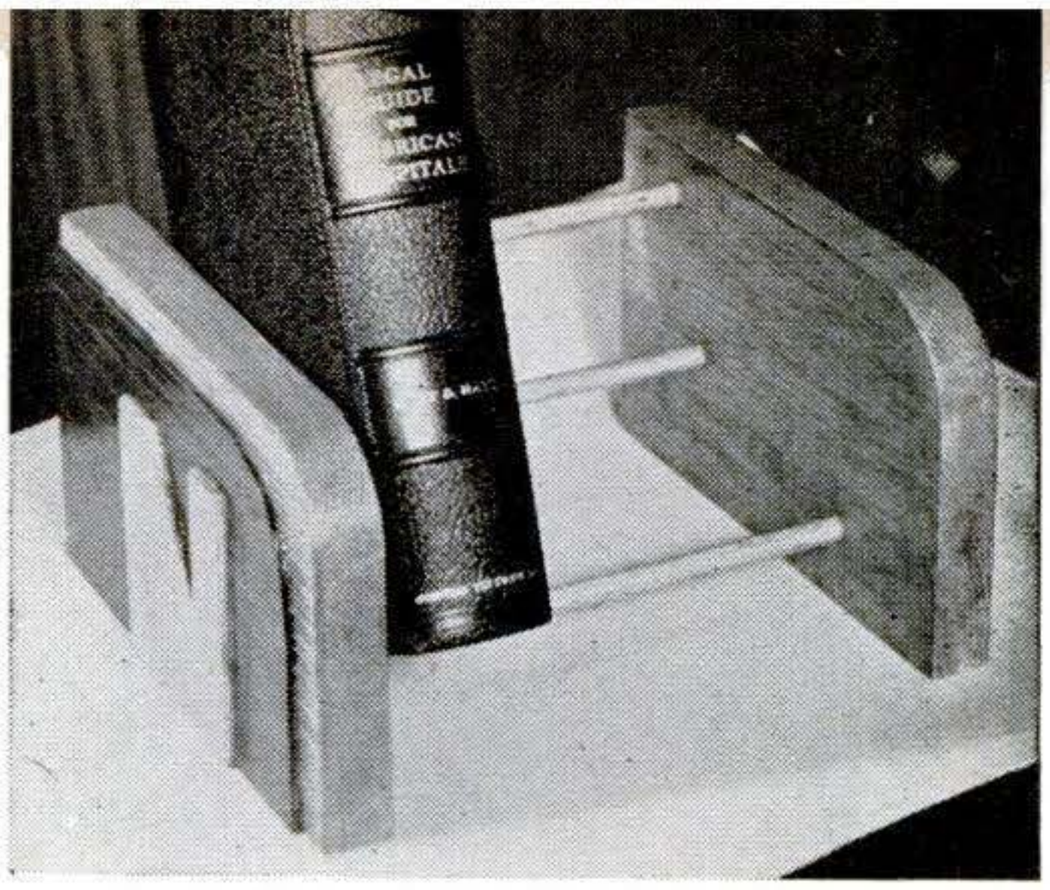
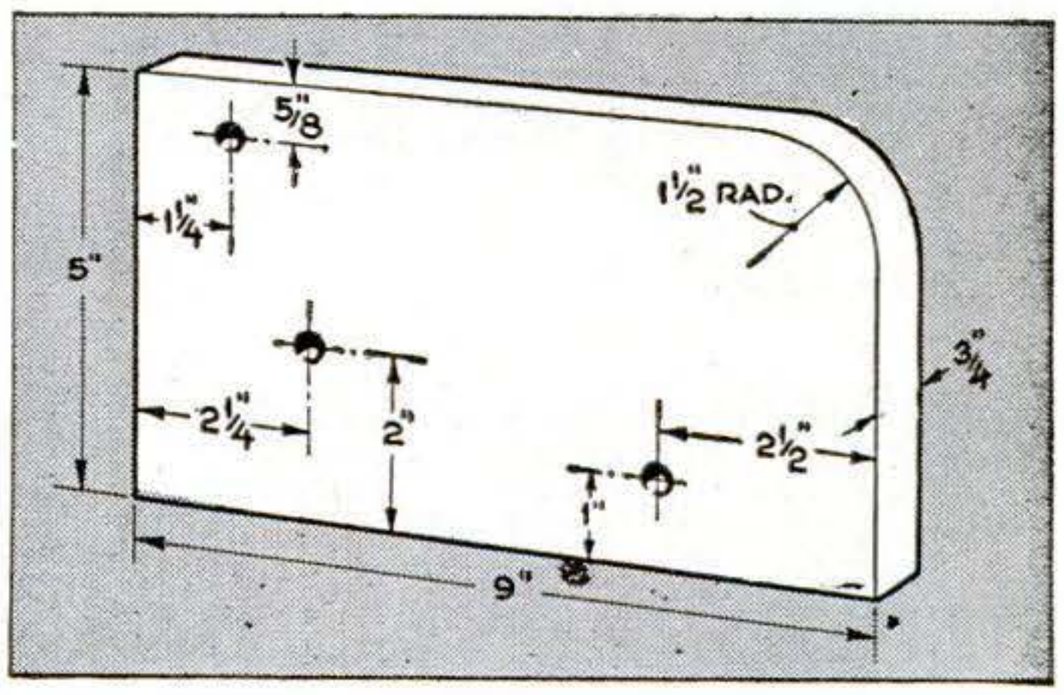
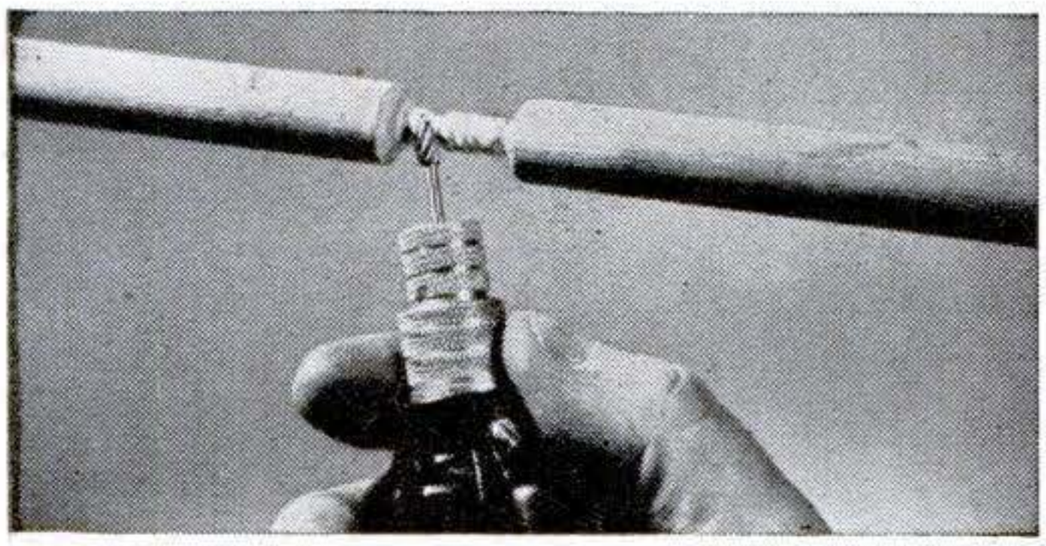
Dowel Rack Tilts Books For Easier Reference



ANY combination of contrasting woods may be used for the ends of this rack that inclines book titles to meet the eye. The ⅜″ dowels supporting the books determine the length of the rack and may be cut to any reasonable size.

The main endpieces of the rack shown are made from ¾″ maple according to the dimensions given in the drawing; they are clamped together and drilled through for the dowel holes in one operation. Over each of these ends a piece of ⅛″ walnut, 4½″ by 8½″ with a 1″ radius, is glued flush with the bottom and back. These outside pieces cover the dowel holes, and are in turn topped by decorative initials jigsawed from 3½″ squares of 1/16″ stock. A natural finish was used to bring out the contrast of the woods. Felt pads cemented under the legs protect desk or table from scratches.



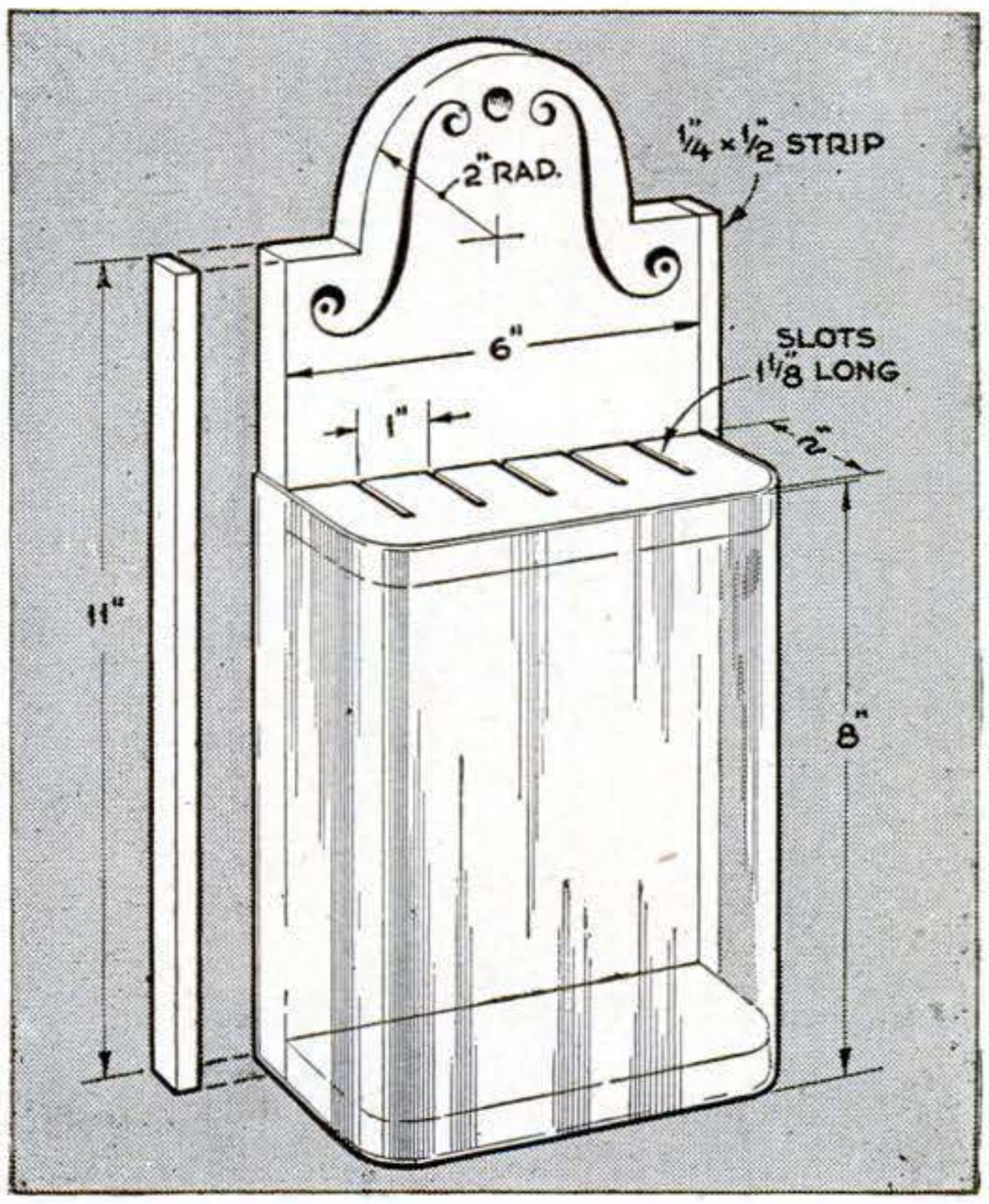


Hand Tool Is Lathe Accessory

WHEN turning wood, plastic, or soft metal to a small section that may break under tool pressure, substitute a hand grinder with a suitable cutting or grinding wheel for the regular cutting tool. Scarcely any pressure will have to be exerted on the work to make the desired cut as the work turns.

Plastic-Front Knife Holder Displays Assorted Blades

A TRANSPARENT shield over this rack enables the housewife to select the proper knife at a glance, yet there are no exposed blades to cause kitchen accidents. The holder can be made of ½″ pine or plywood and a sheet of plastic measuring about 8″ by 9″. After the wood is cut to the dimensions shown, it is sanded, painted, and assembled except for the two side strips. The plastic is tacked to one edge and the strip nailed on top of it. A little plastic cement is applied to the two rounded front pieces, and the sheet is wrapped tightly around, then nailed and clamped under the other strip. Nails are countersunk, and the edges given another coat of paint or enamel to cover the heads. A decal transfer may be applied to the plastic or the upper part of the rack for ornamentation.—RALPH S. WILKES.



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This Stool Goes Modern

Sturdy and comfortable kitchen or playroom seat is upholstered with new and colorful plastic materials.

By Walter E. Burton

IF YOU shy away from projects involving upholstery, take a look at the modern materials that are so simple to use and give such eye-filling results. Foam rubber does away with fussy packing and forms an air-filled cushion. Synthetic covering fabrics are easily applied, proof against common hazards, and reasonably priced. Then look again and see your kitchen or playroom spruced up with one or more of these up-to-the-minute stools.

In keeping with its modern materials, the stool shown has simple, functional lines. Seasoned maple is used for the frame, the exposed parts being matched in tone so that the wood can take a natural finish when the stool is completed.

For the legs, 1¾″ by 1¾″ by 28″ lengths of stock are taper-sawed to remove material from the two inner faces only. Notch the upper ends of the legs to receive the rails, fastening these with glue and countersunk screws. Nail cleats inside the seat recess to support a ⅜″ plywood bottom. Bore a dozen ¼″ holes in the plywood so that air can escape from or enter the sponge-rubber cushion.

Attach the four stretchers to the legs by glued mortise-and-tenon joints. When forming the tenons, cut their shoulders at angles that match the spread of the stool legs, that is, 4 deg. front and back, and 6 deg. on the sides.

Like the legs, the back posts are taper-sawed from 1¾″ square stock. Cut the top portion on the outer and front faces, and the 9″ long lower taper on the inner and front faces. Two horizontal slats are mortised into the uprights and glued and dowel pinned for extra strength. The back is glued, screwed, and bolted to the seat frame to provide permanent rigidity.

Sand the frame smooth, rounding all corners and edges; then give the parts that will be exposed two or three coats of fairly thin shellac. Rub each coat with fine sandpaper or steel wool before applying the next.

Over the plywood, tack a layer of burlap. Latex sponge rubber, 1″ thick, is used for the seat cushion. Cut a piece to fill the recess, using ordinary scissors. To build up the center, slice a smaller slab to a thickness of about ½″ and scissor it all around to a feather edge. Next, take a 1″ slab that is ½″ larger all around than the seat frame. Apply rubber cement to the bottom slab and press the next one against it. Separate the pieces until the cement has become

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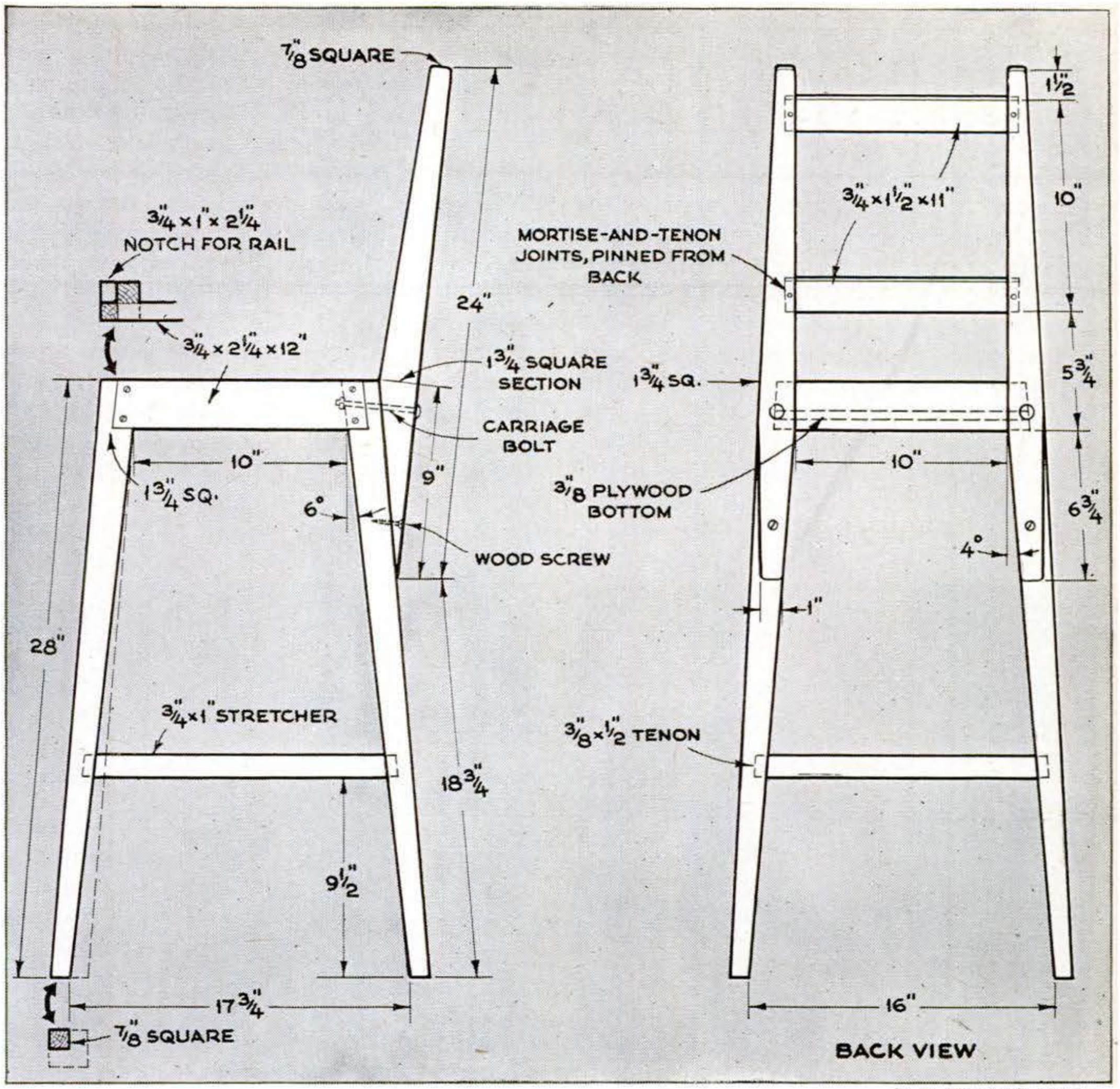
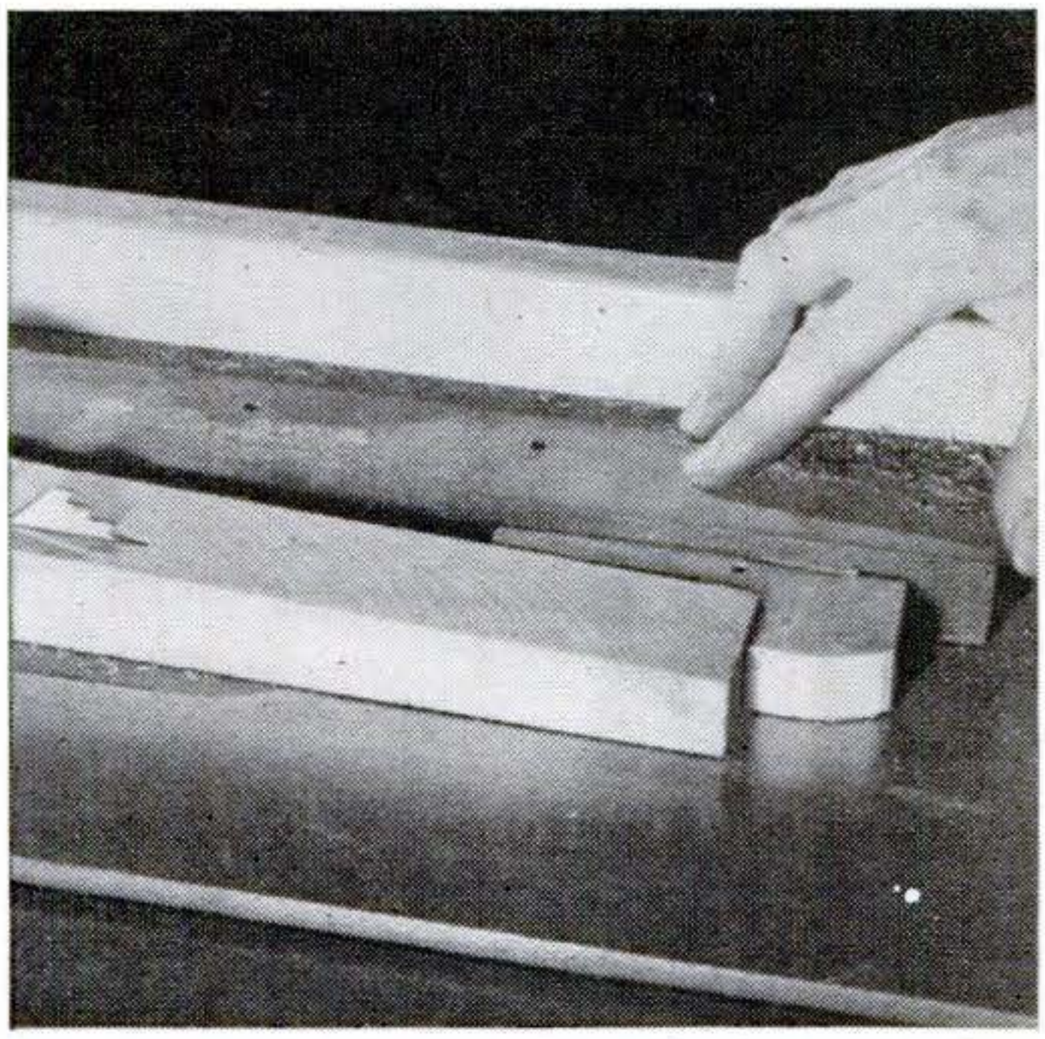
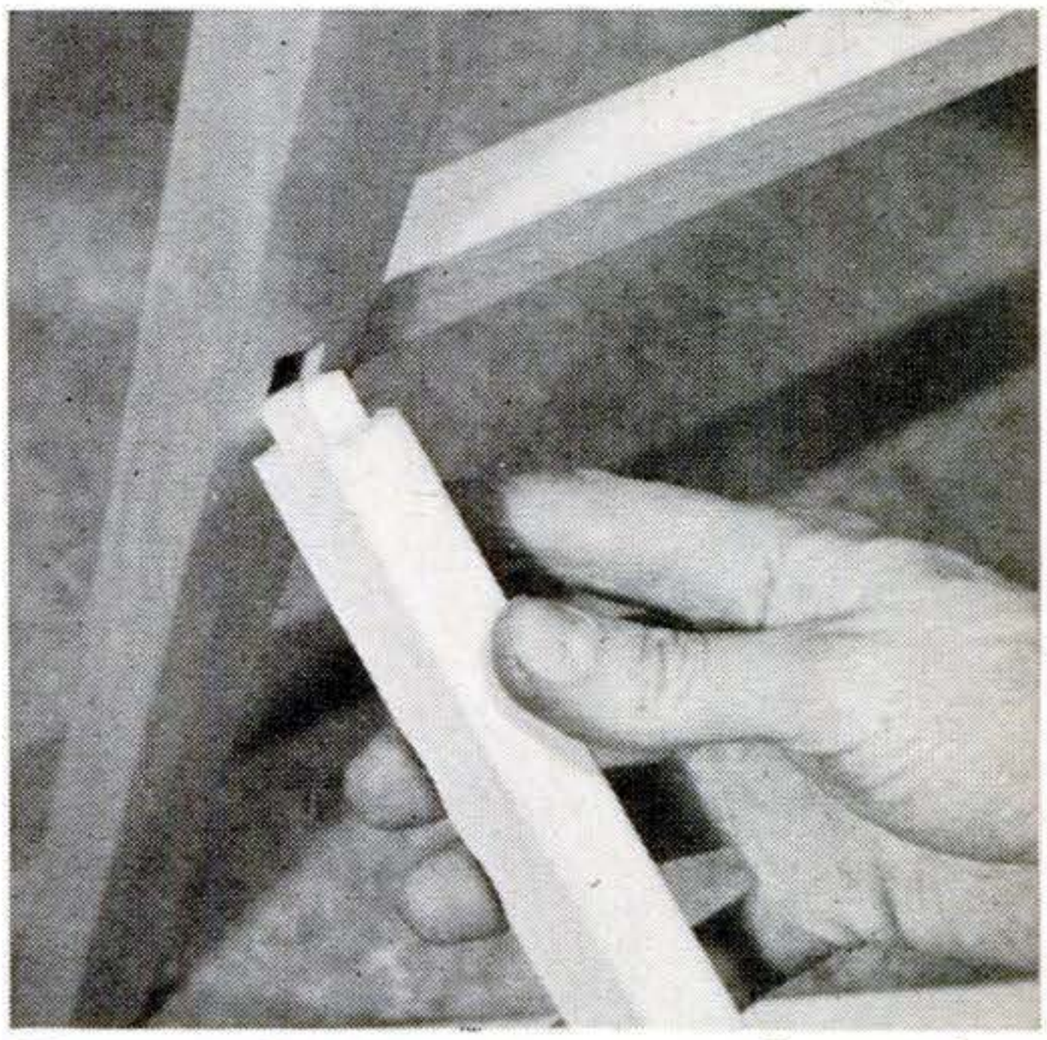


B. F. Goodrich photos



Legs are tapered with the aid of a notched jig that holds the lower end of the stock away from the fence. Here the second cut is being made.



Mortise-and-tenon joints secure the stretchers to the legs. Cut the shoulders of the tenons at angles that match the spread of the legs.

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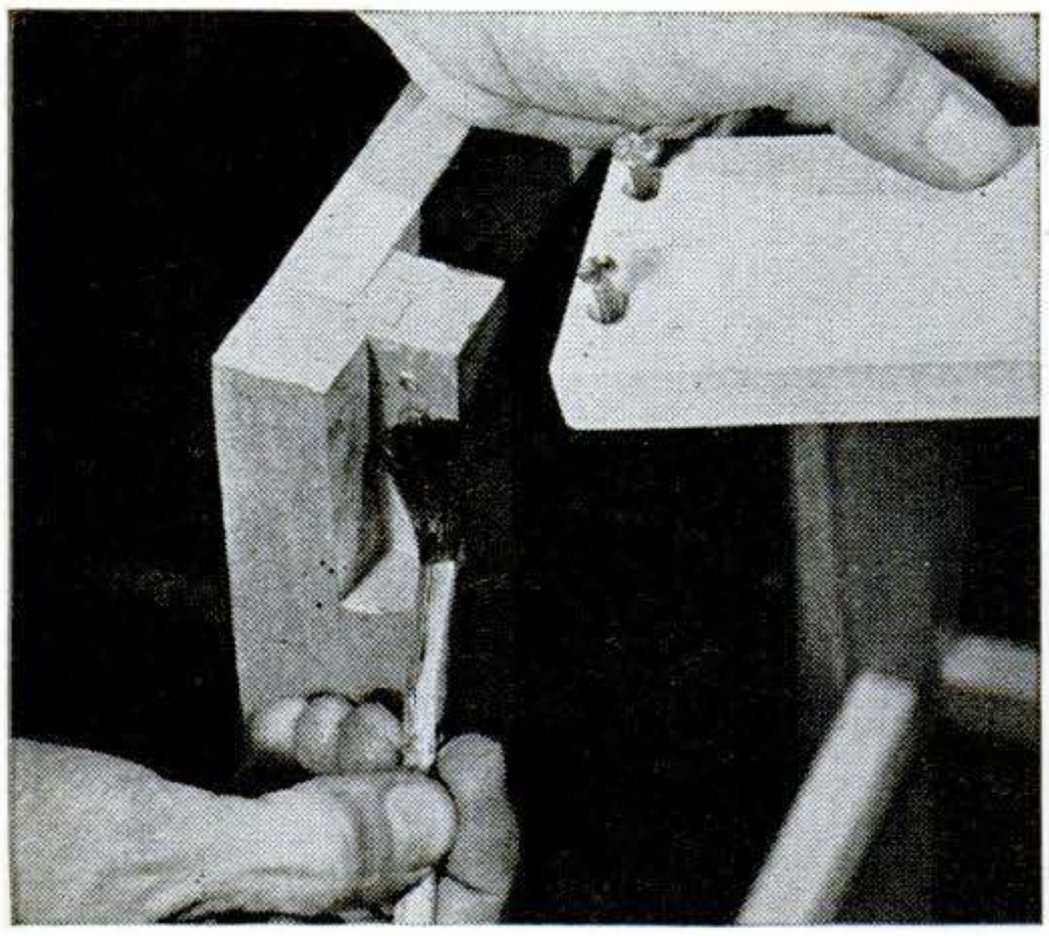
tacky, then replace the upper piece carefully. The cushions cannot be shifted once the cemented areas touch. Round or bevel the edges and corners of the top pad to improve the appearance.

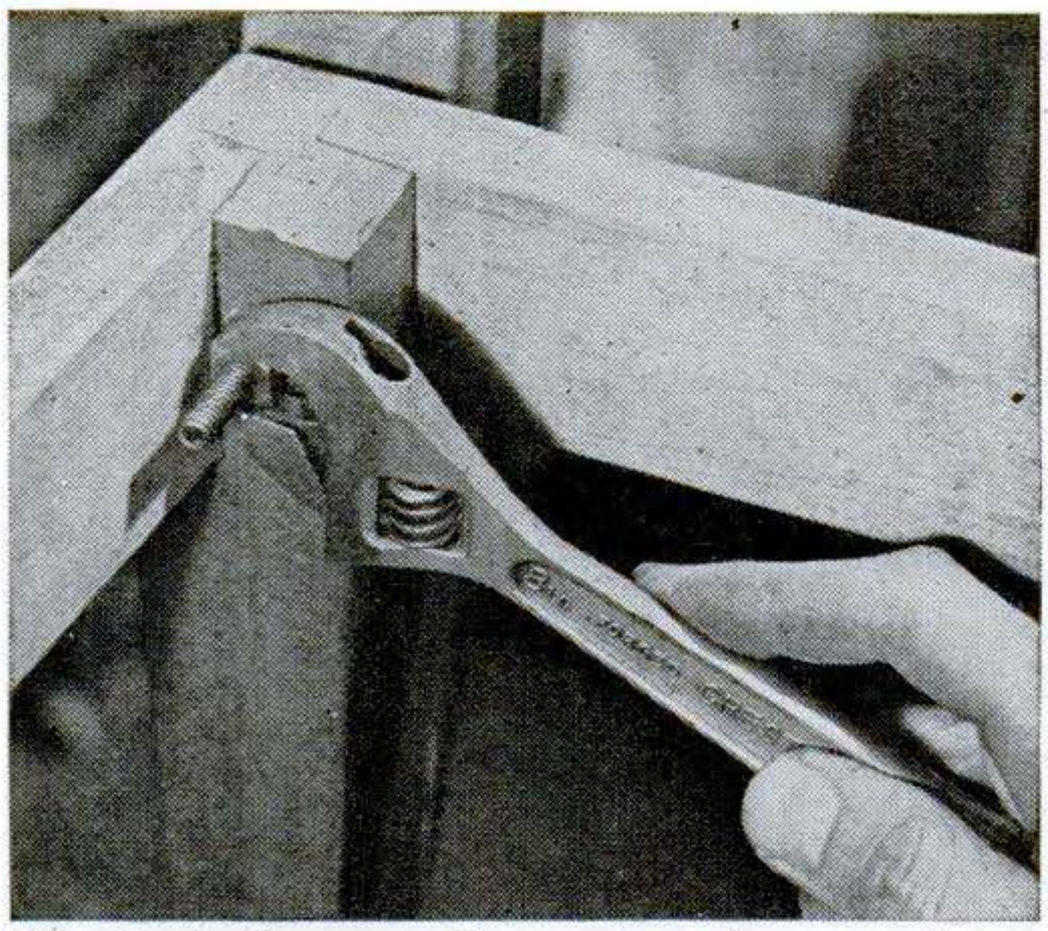
Koroseal sheet, a vinyl-plastic material with a fabric backing, can be applied directly over the rubber. Allow plenty of material all around, and pull the sheet into position with wide-nosed pliers. Vinyl-plastic materials must not be drawn too tightly. Use temporary tacks, driven into the lower edges of the rails, to hold the material until final tacking.

Corners are rolled instead of being sharply folded; edges are folded under about ½" all around, and upholstery nails are driven so that their heads are about ⅛" from the fold. A nonmarring plastic hammer is recommended. The cover should be fitted neatly around inside corners of the back posts.

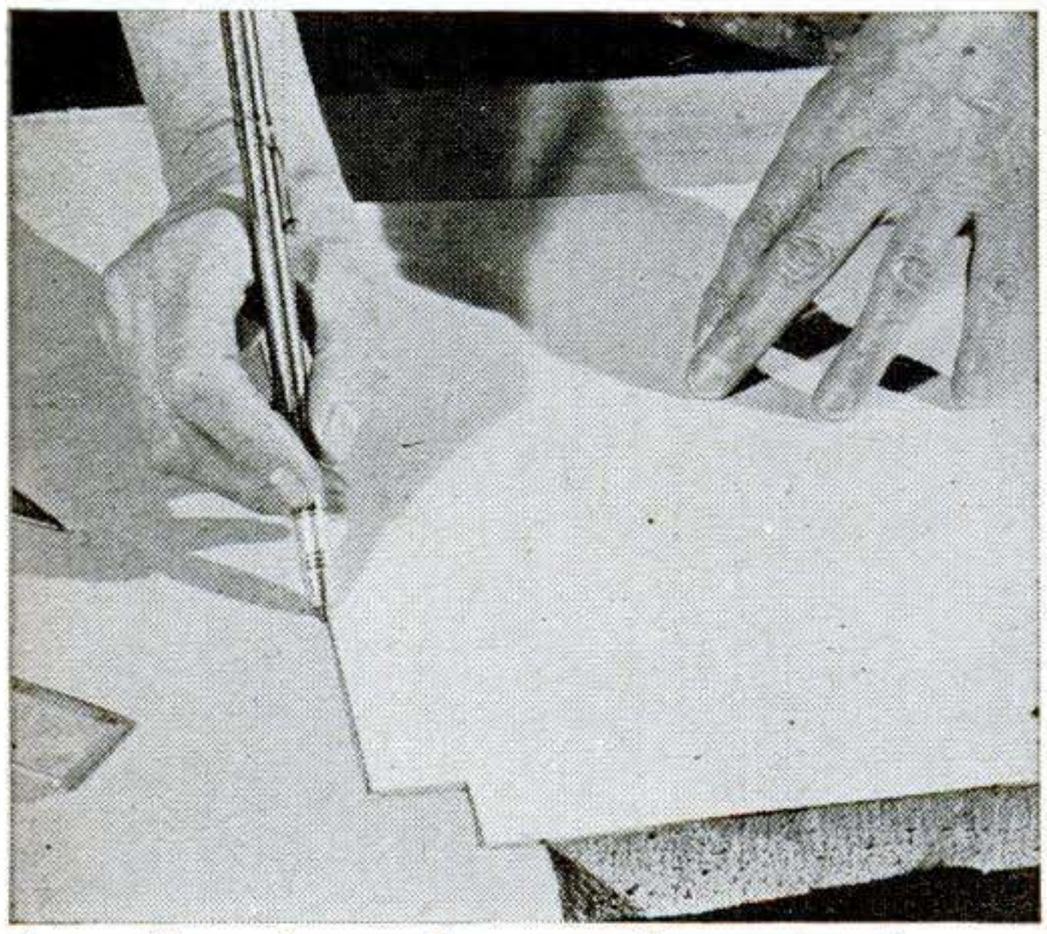
Furniture rodding, an extruded flexible cord about 3/16" dia., or plastic clothesline may be used on the back frame. About 90′ of rodding or line will be needed. Fasten one end of the cord to the bottom edge of the lower slat adjacent to the post. You may find it desirable to strengthen the back by inserting a muslin-wrapped cushion of sponge rubber between the windings. If so, cut the cushion to fit the opening snugly and insert it when the winding is about half completed. Should it be necessary to start a new length of rodding, do so under the lower crosspiece and use small nails to hold the ends. END



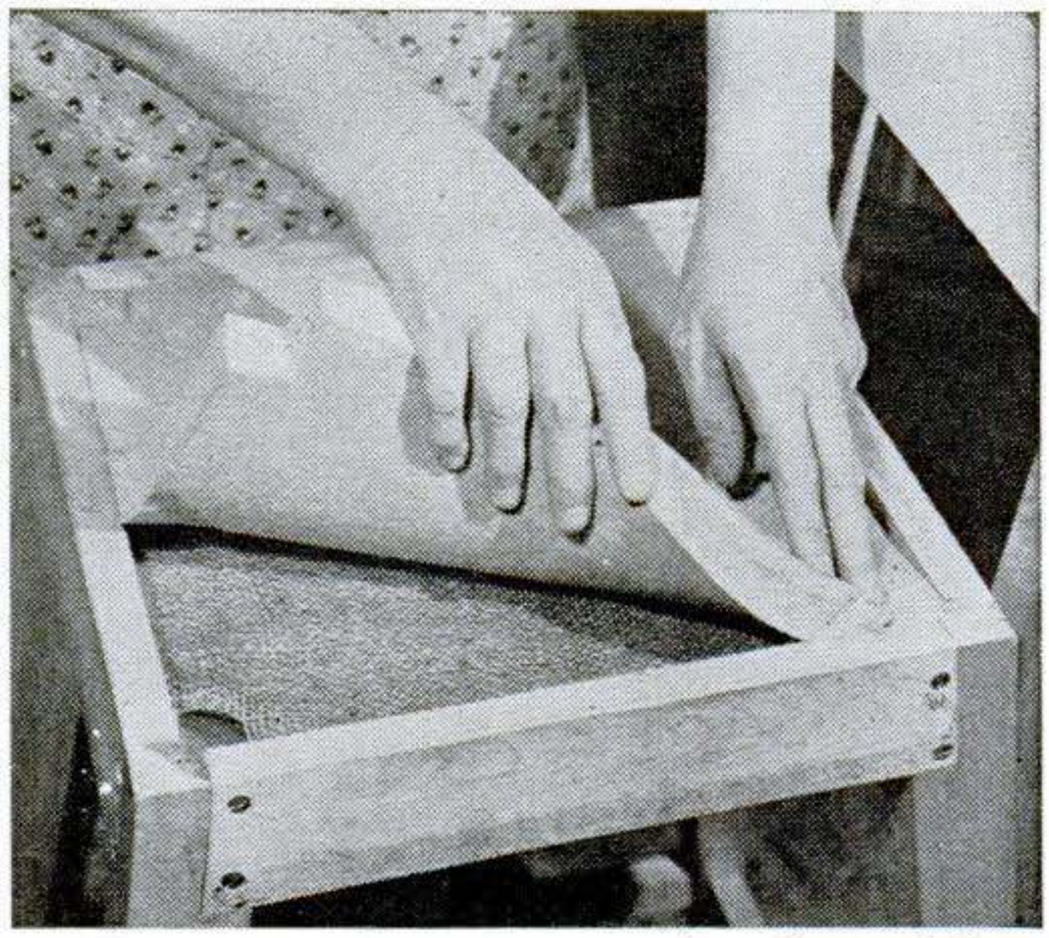
Seat-frame rails are notched in and both glued and screwed. Their ends are cut at an angle to give proper spread of the legs.



The back frame is fastened to the main frame by carriage bolts whose ends project into the seat-pad cavity; wood screws are also used.



A cardboard template may be used to lay out the sponge-rubber cushion that goes inside the seat cavity. Use scissors to cut the rubber.



Drill several vent holes in the plywood bottom, cover it with a layer of burlap, and install the fitted foam-latex cushion.

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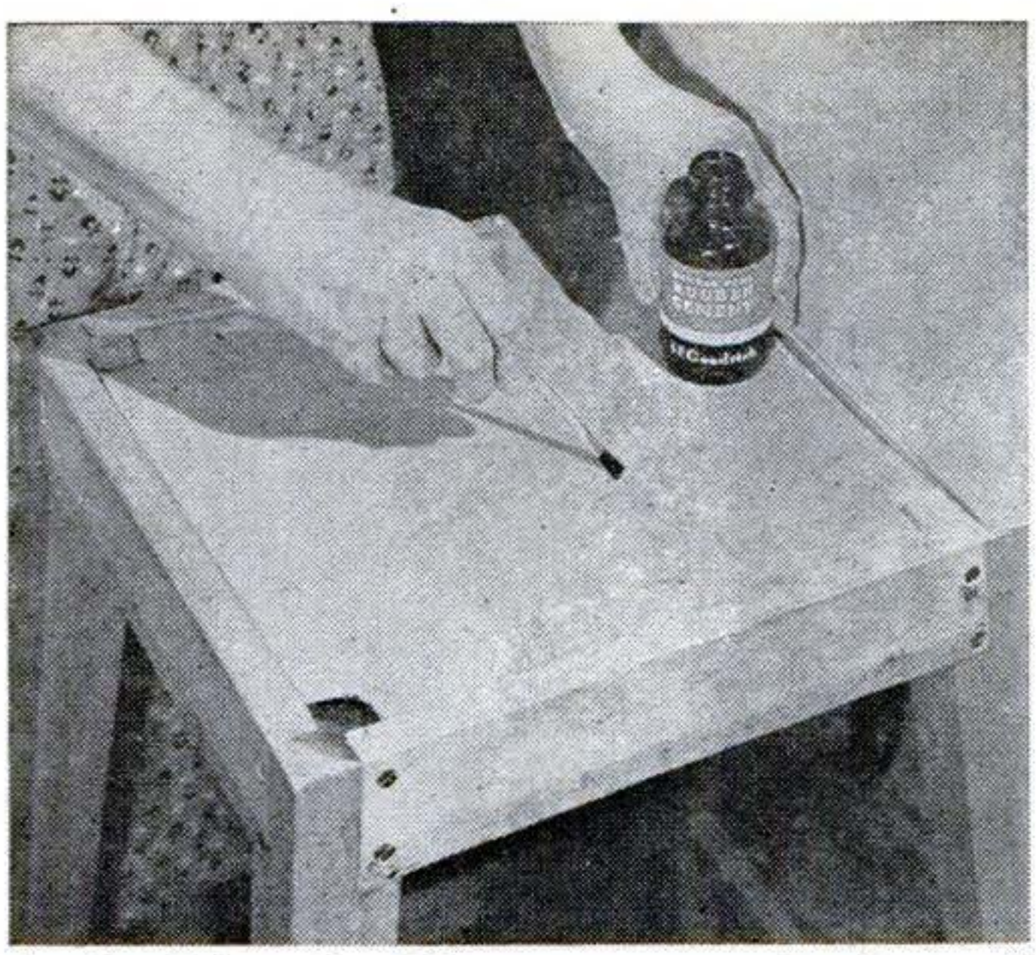
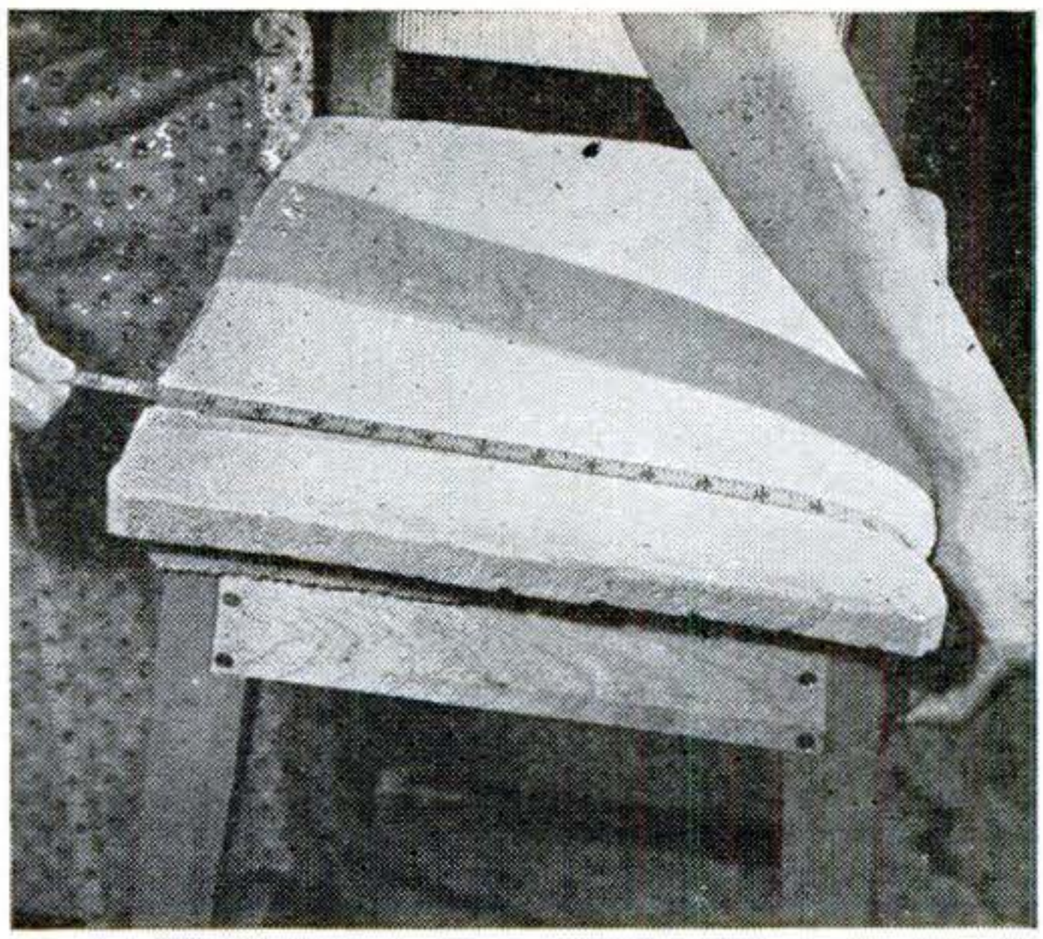
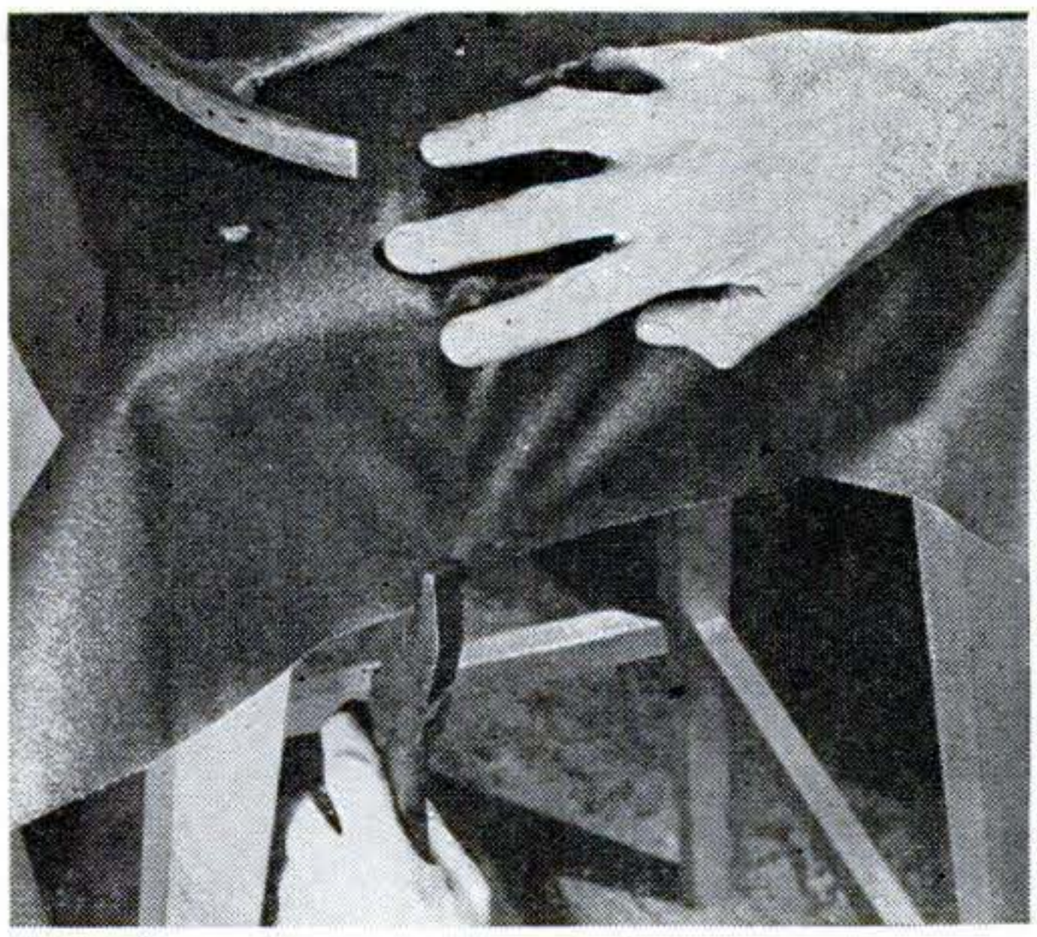


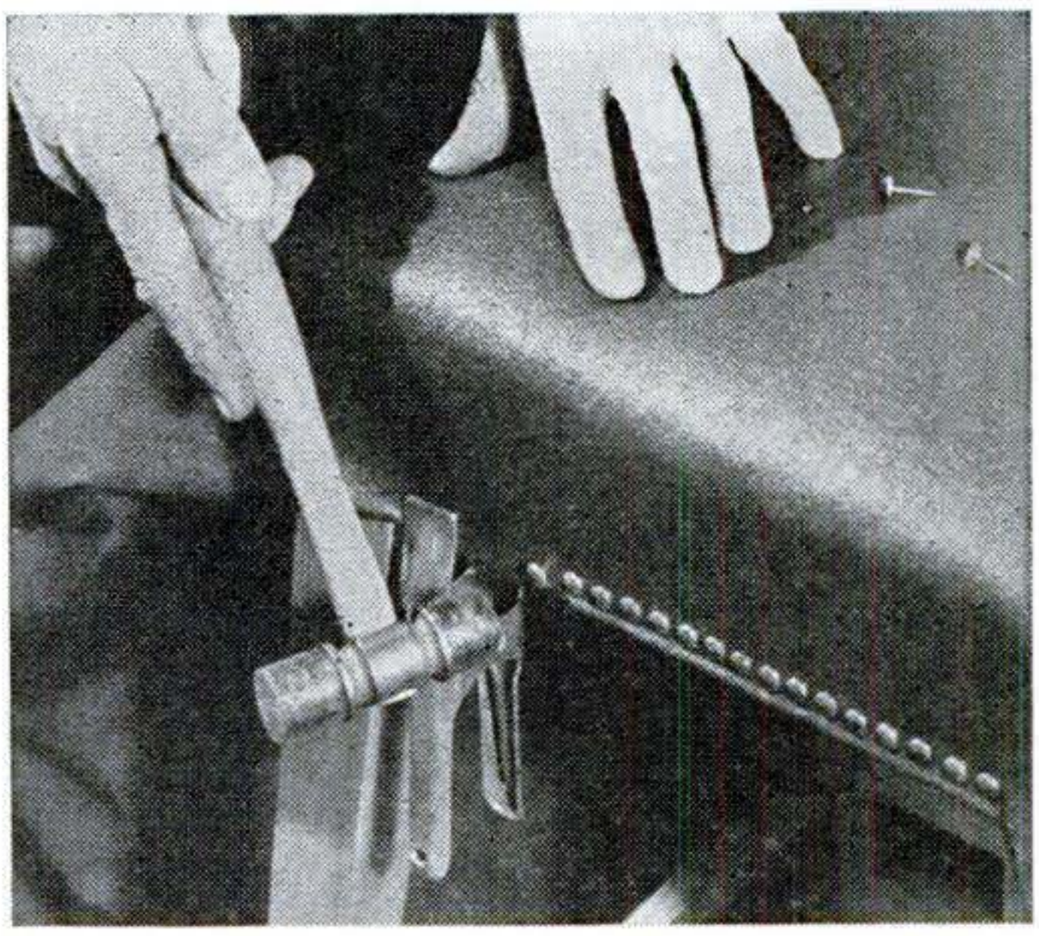
Apply dabs of rubber cement to the first pad before installing the next one or two cushions. Cement from an inner-tube repair kit will do.



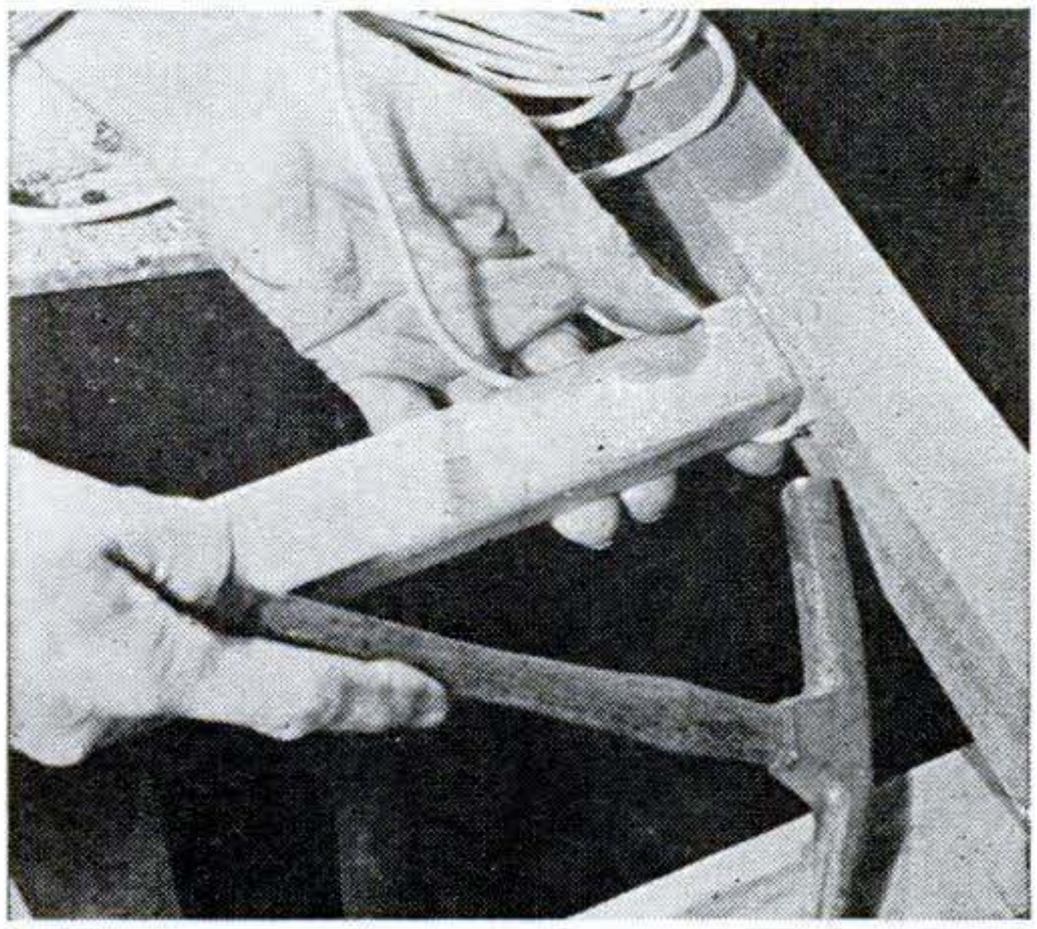
Measure the seat contour to determine the size of the cover. Three pads were used here; the edges of the top one shown were later beveled.



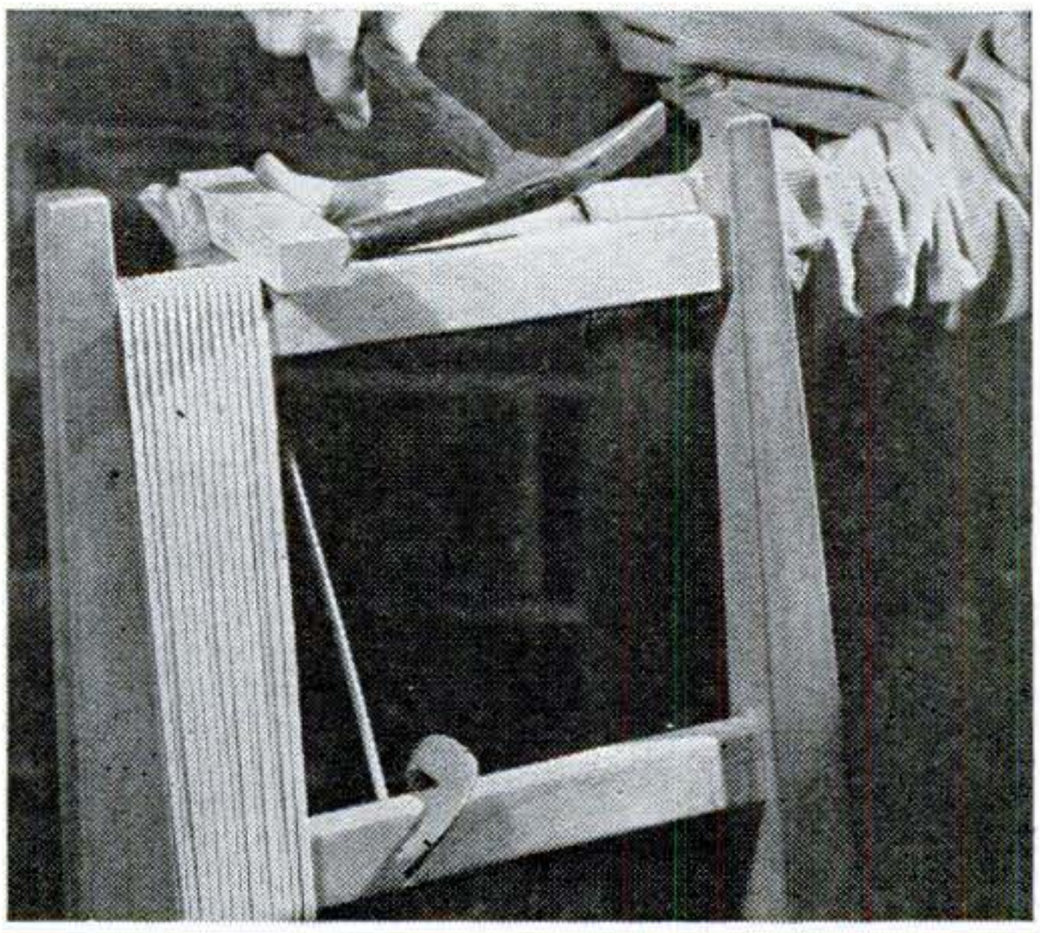
Upholstering material is pulled into position with wide-nosed pliers and held by temporary tacks driven into the lower rail edges.



Brass-headed upholstery nails are spaced close together. Rolled corners are recommended when using vinyl-plastic upholstering materials.



Koroseal clothesline, a flexible plastic cord, is used for the back. Before starting to wind it, fasten one end with two small nails.



Compact the windings at every few turns with a hammer and wooden block. The free end of the rodding can be held taut with a clamp.

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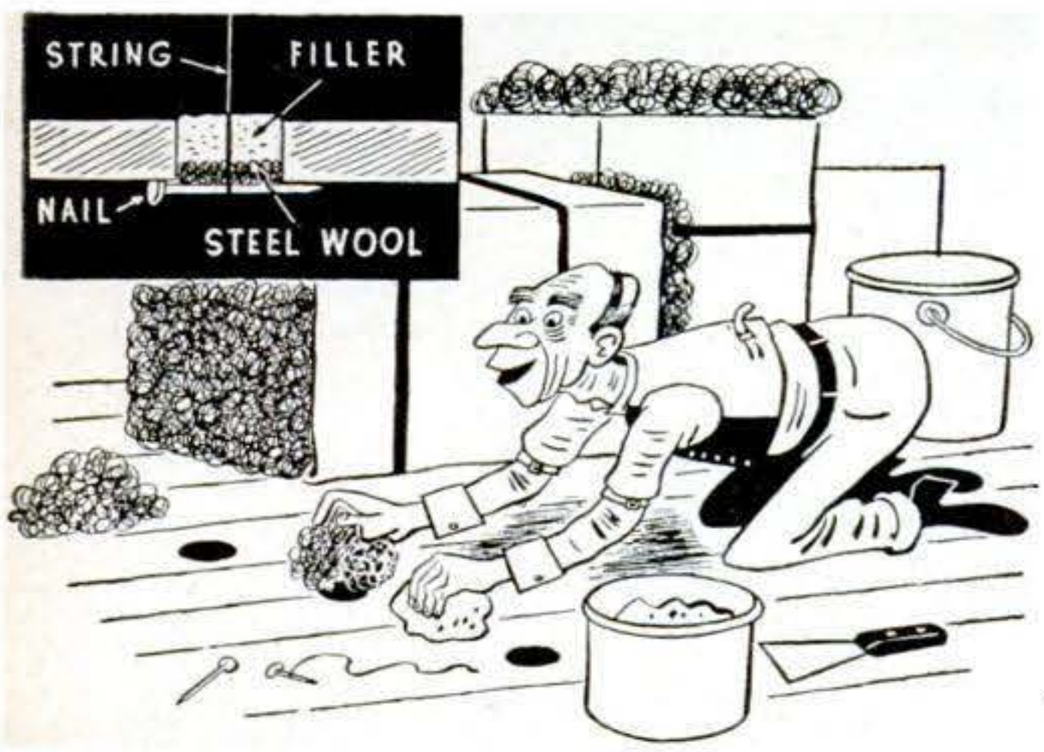
WHAT'S YOUR INGENUITY QUOTIENT? IQ

Raising the Roof is easy, but putting up a ceiling is another story. I had to hold some large sheets of fiberboard against the ceiling while I nailed them in place, so I fastened a wooden T to a folding ladder. With the ladder open the top of the T was about 2″ from the ceiling. The sheet was balanced on top, and closing the ladder lifted it into place. Then I stood on another ladder to nail it fast.—H. A. Crandall.



I'll Plug for This Plug. Stopping holes in a wall or floor used to mean pushing large quantities of filler right through, because I couldn't close the far side. Now I tie a large nail to a string, drop it in, and pull it tight crosswise while stuffing in a wad of steel wool. This, in turn, forms a floor for the filler. When this hardens, I cut off the taut string level with the top. Steel wool, incidentally, serves to make the plug ratproof.—A. H. W. Birch.

Don't Get Alarmed. If your clock is broken and you have to wake up by a certain hour, time the rate at which a candle burns. Measure off the hours on the candle, and tie a string at that point. A tin can poised to fall into a dishpan will rouse you at the zero hour.—C. M. Cross.

It's a Lot of Hot Air, but that's the best thing in the world for thawing inaccessible water pipes. When one of my pipes froze, I attached the blower tube to my vacuum cleaner, put the outlet under a loosened board near the cold pipe, and held the nozzle over a heater.—Paul Morrow.

Have you pulled off a smart one lately? We will pay for acceptable contributions showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky — if it works.

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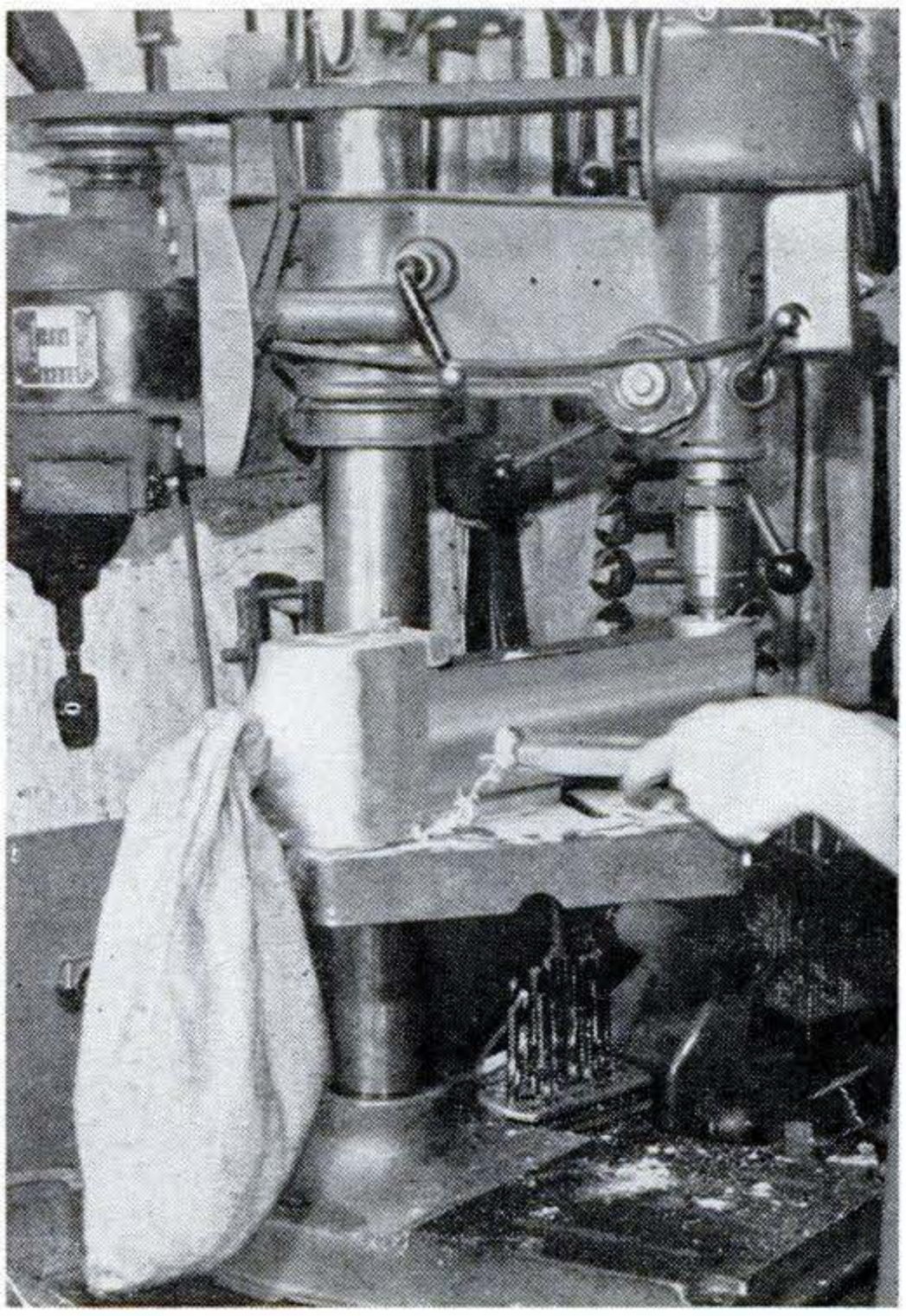
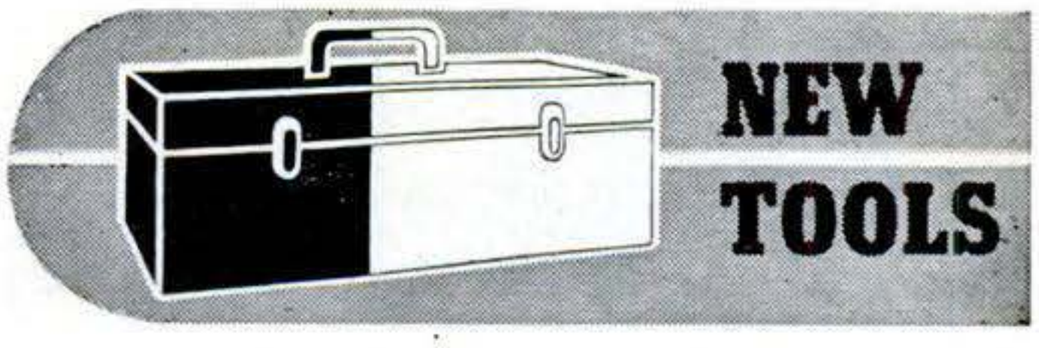
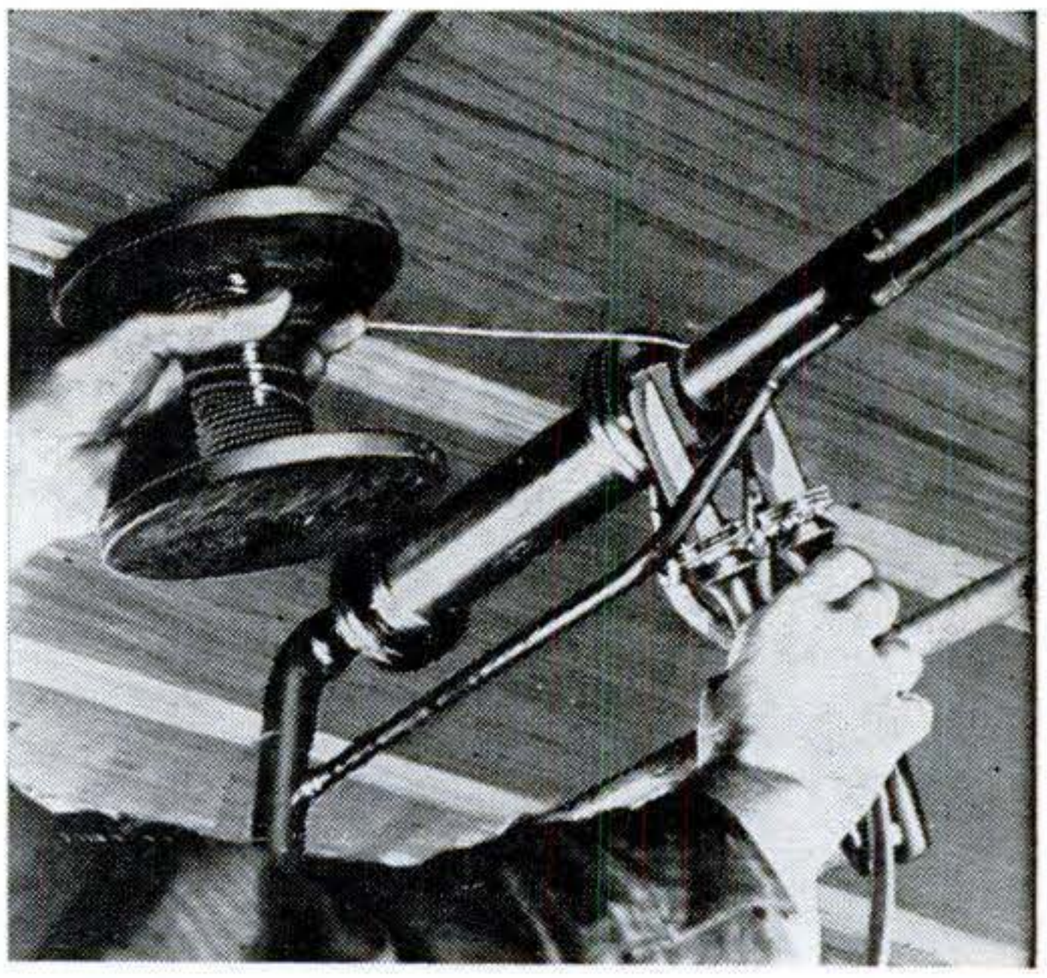
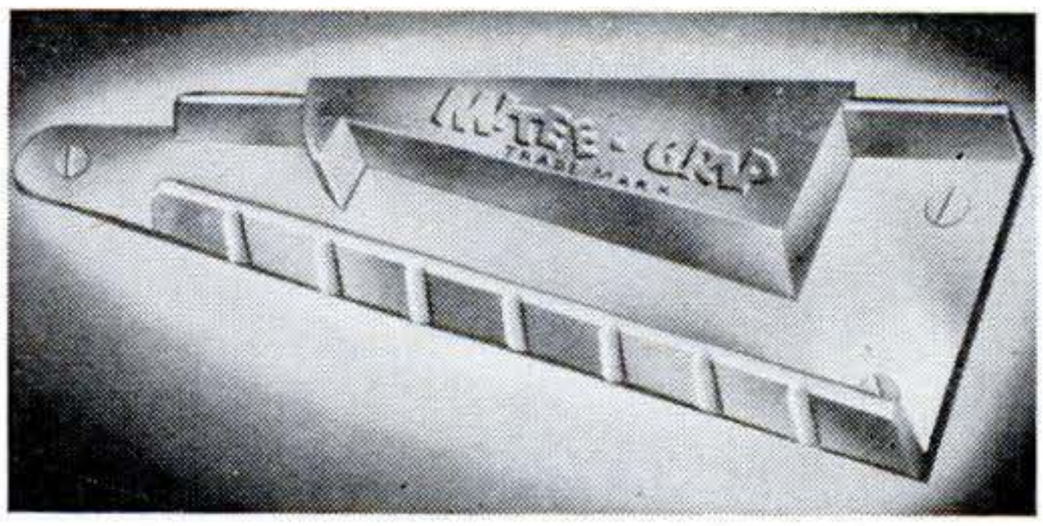






Belt Sander for Drill Press. A new belt sander for use with a drill press is being produced by the OK Specialty Company, of Chicago, Ill. It may be adjusted to take belts from 26″ to 36″ long and up to 3″ in width. The outfit consists of a cast aluminum base, an aluminum backing plate or platen, a driven pulley mounted on a ½″ shaft, and a driver pulley on a ½″ steel shaft that fits the drill-press chuck.

Soldering with "Pliers." Powered by a transformer, this soldering tool made by Ideal Industries, of Sycamore, Ill., looks like a pair of pliers. Holding the work between the jaws of the tool completes the transformer secondary circuit and causes the work to heat, the heat being chiefly confined to the space between the electrodes. Radiating fins isolate the jaws from the handles to prevent excessive heat conduction. If desired, the tool may be locked in any position by tightening a screw at the hinge.



Bench Stop Adjusts. A sliding member on this aluminum bench stop adjusts automatically to work of various widths and grips it firmly for operations ranging from light sanding to rough planing or sawing. When the job is finished, an easy push releases the work. Three holes are provided for screwing the stop to the bench or a portable board. Made by the Elroy Products Co., Minneapolis, it sells for about $2.50.

Planer Uses Band-Saw Blade. A drill-press planer introduced by Mastercraft Products, of Boston, Mass., has a multi-toothed cutter instead of the usual three or four blades. It uses an 8⅝″ length of ⅝″ band-saw blade, easily replaced when the teeth wear down. The aluminum head is balanced. The planer sells for $6.50.

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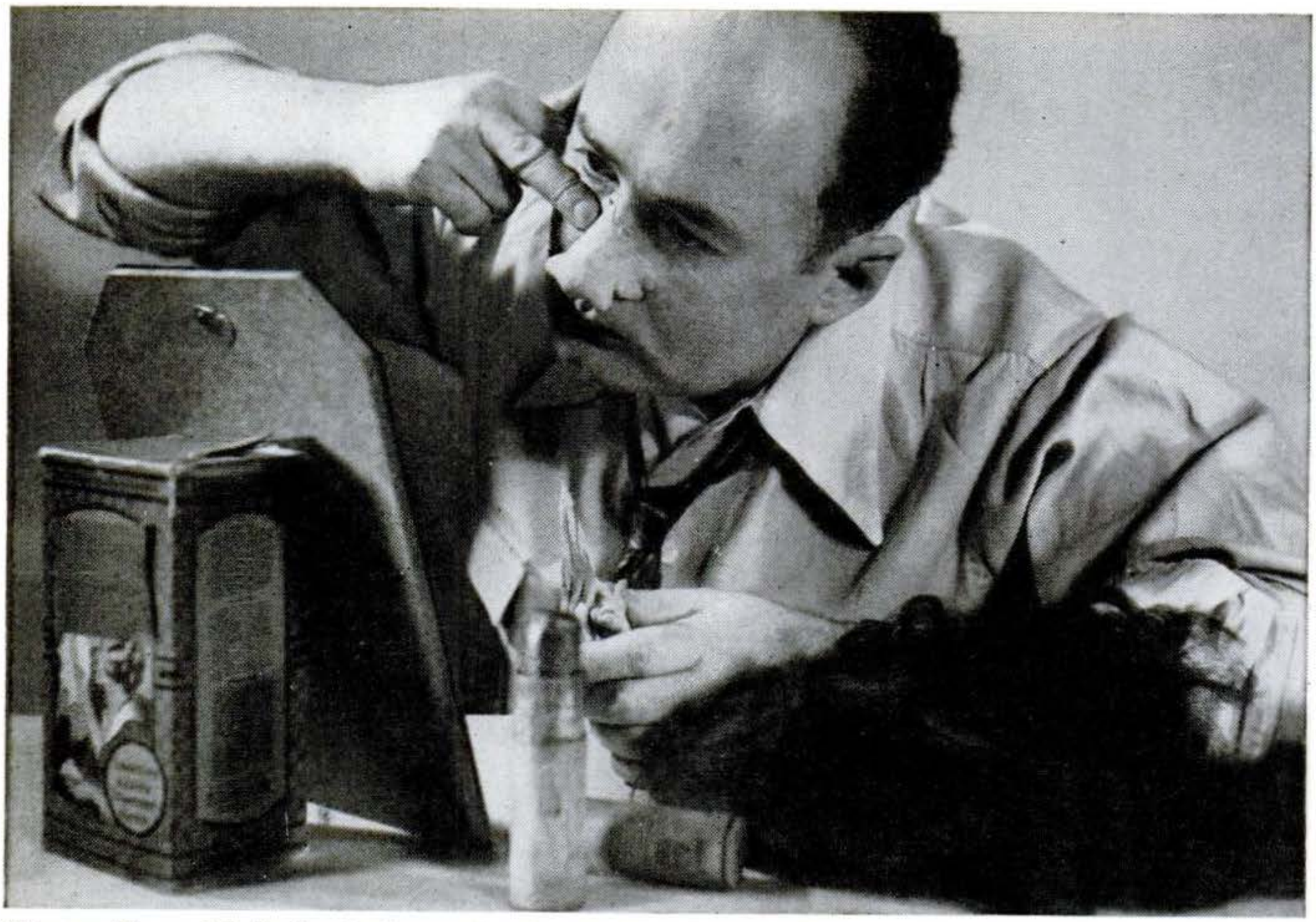
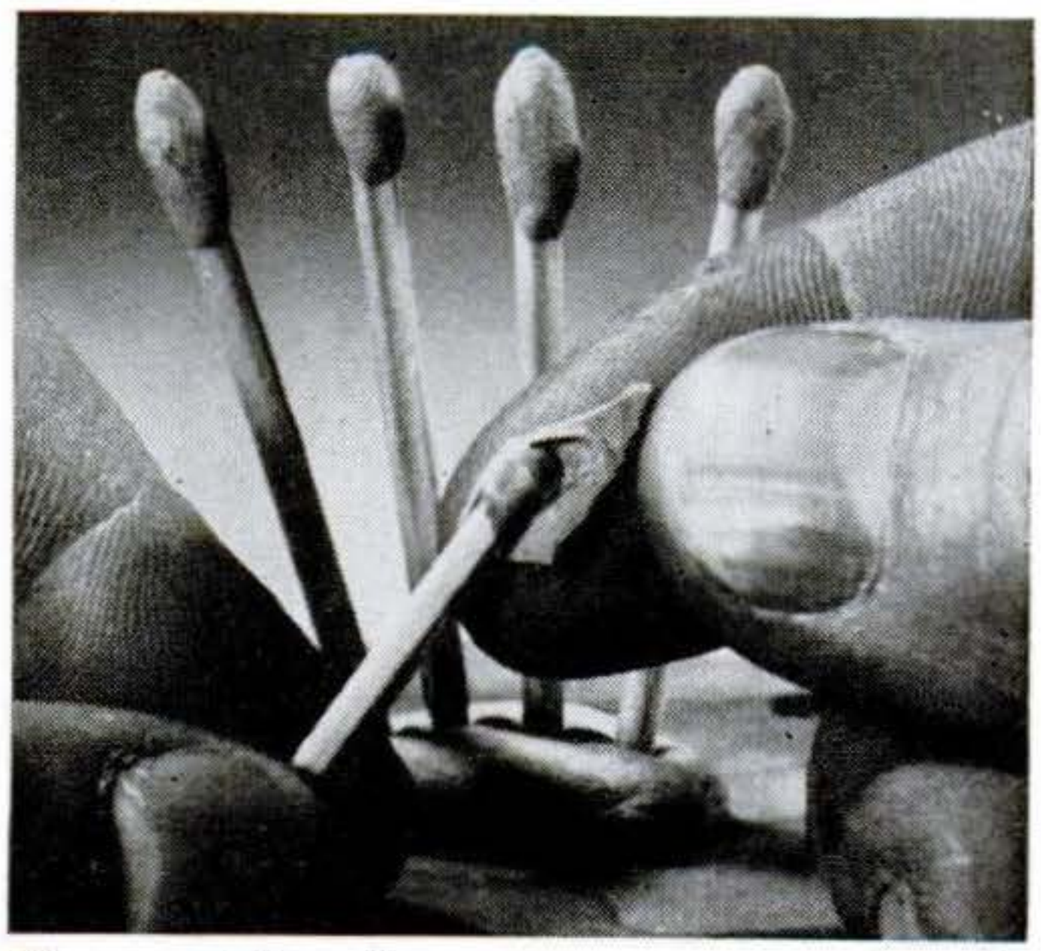


The easily molded plastic keeps its shape. Try it as makeup putty for amateur theatricals.

Extra Uses for Plastic Weatherstripping

THE adhesiveness of plastic weatherstripping and similar calking compounds makes them ideal for a wide variety of applications. Some uses are illustrated here and others crop up constantly in the home, shop, and office. Surfaces held together by the sticky stuff will come apart when you want them to, since it never hardens permanently. Don't worry about getting it on the furniture; it comes off easily.—KENNETH MURRAY.

Attach sandpaper to a disk by spreading the plastic on the disk or paper back with a knife.



Keep matches dry on your next camping trip by covering their heads with removable plastic.

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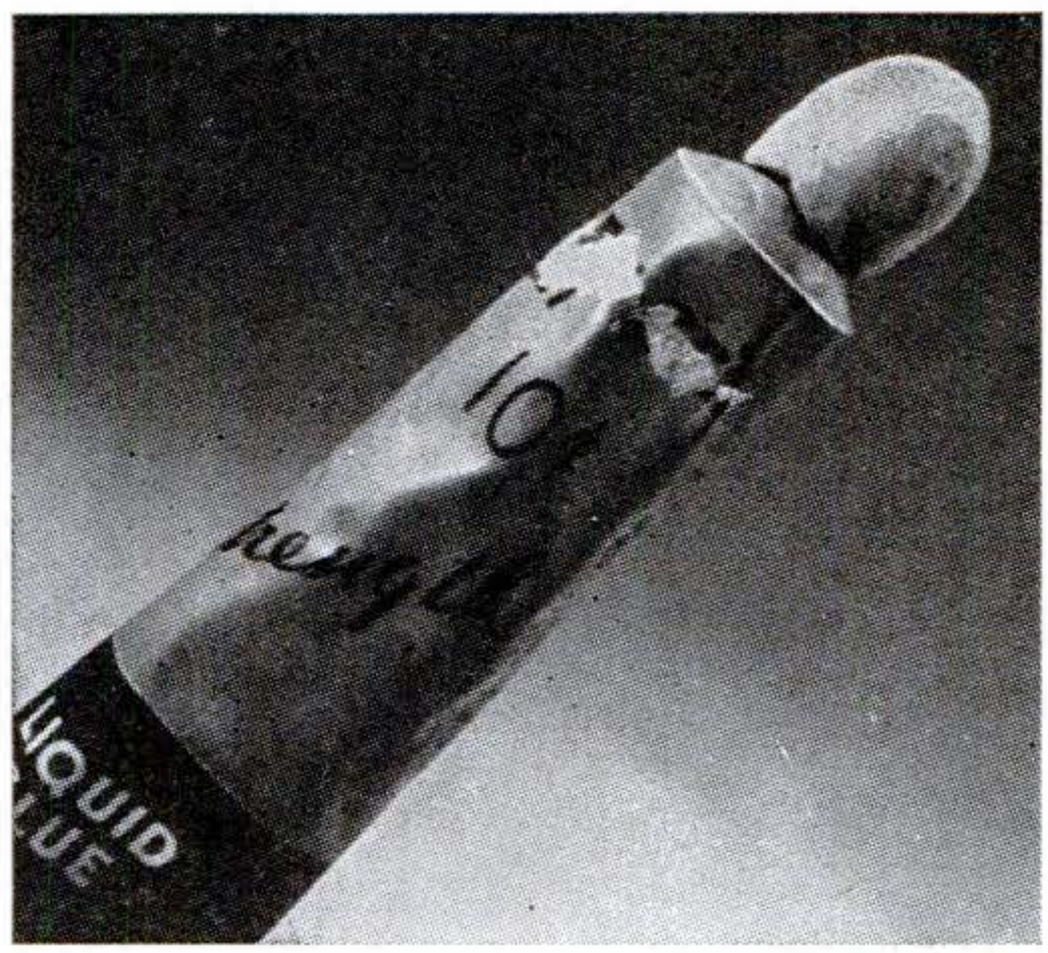
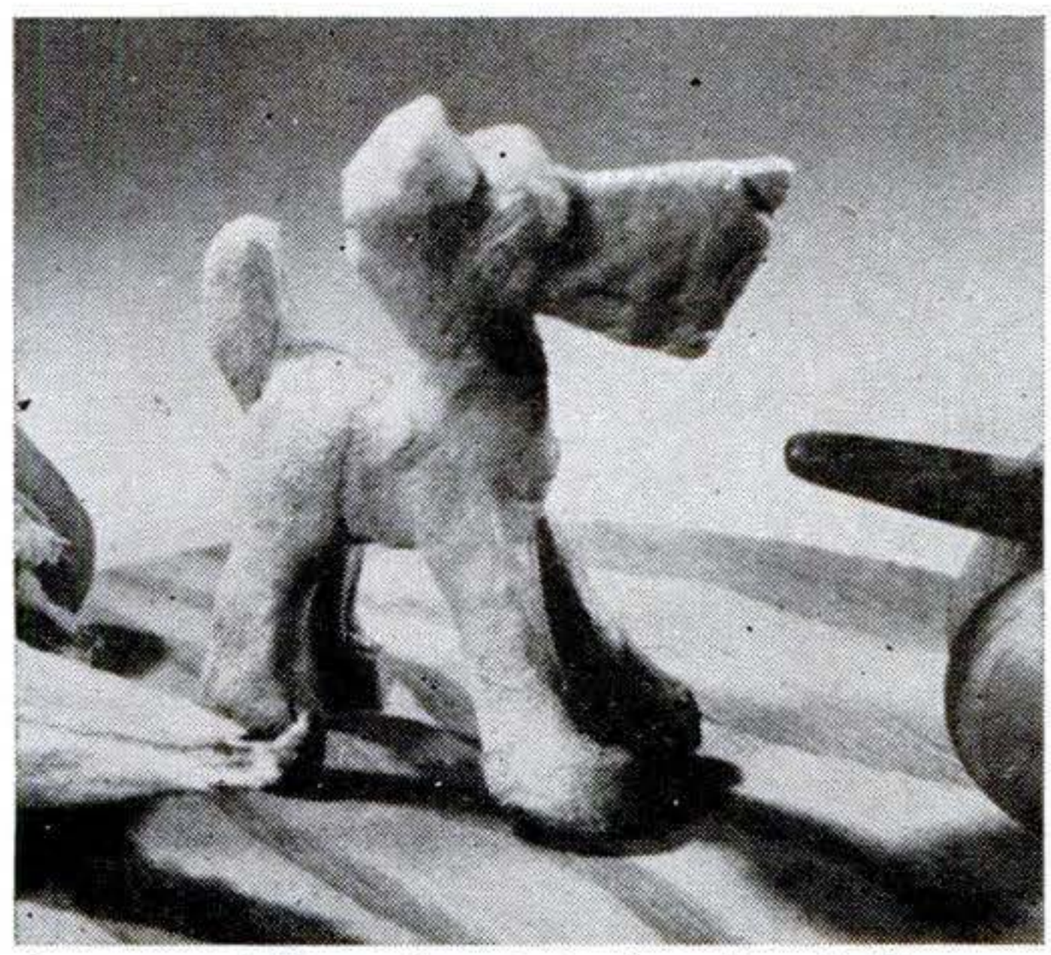
Titling amateur movies is another application. Here letters are stuck on a glass background.

For casting duplicates of a design in plaster or plastic, this mold will retain sharp detail.

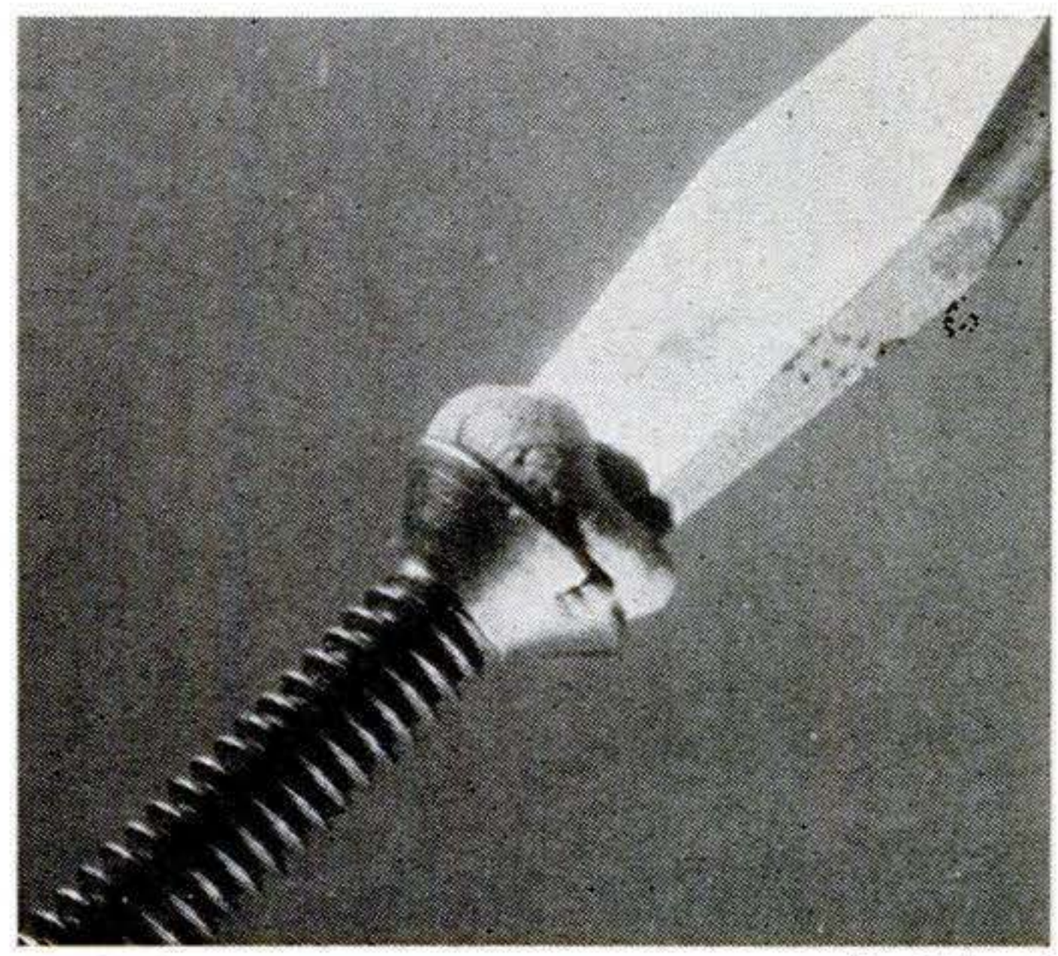


If you lose the cap for a collapsible tube, let plastic keep the contents in good shape.

Flatten a ball of plastic under an ink bottle. The bottle will resist both tipping and spilling.



As a modeling clay it is fine for children or for your own part-time attempts at sculpture.



And for starting screws, try a small dab of the compound on the screwdriver or screw head.

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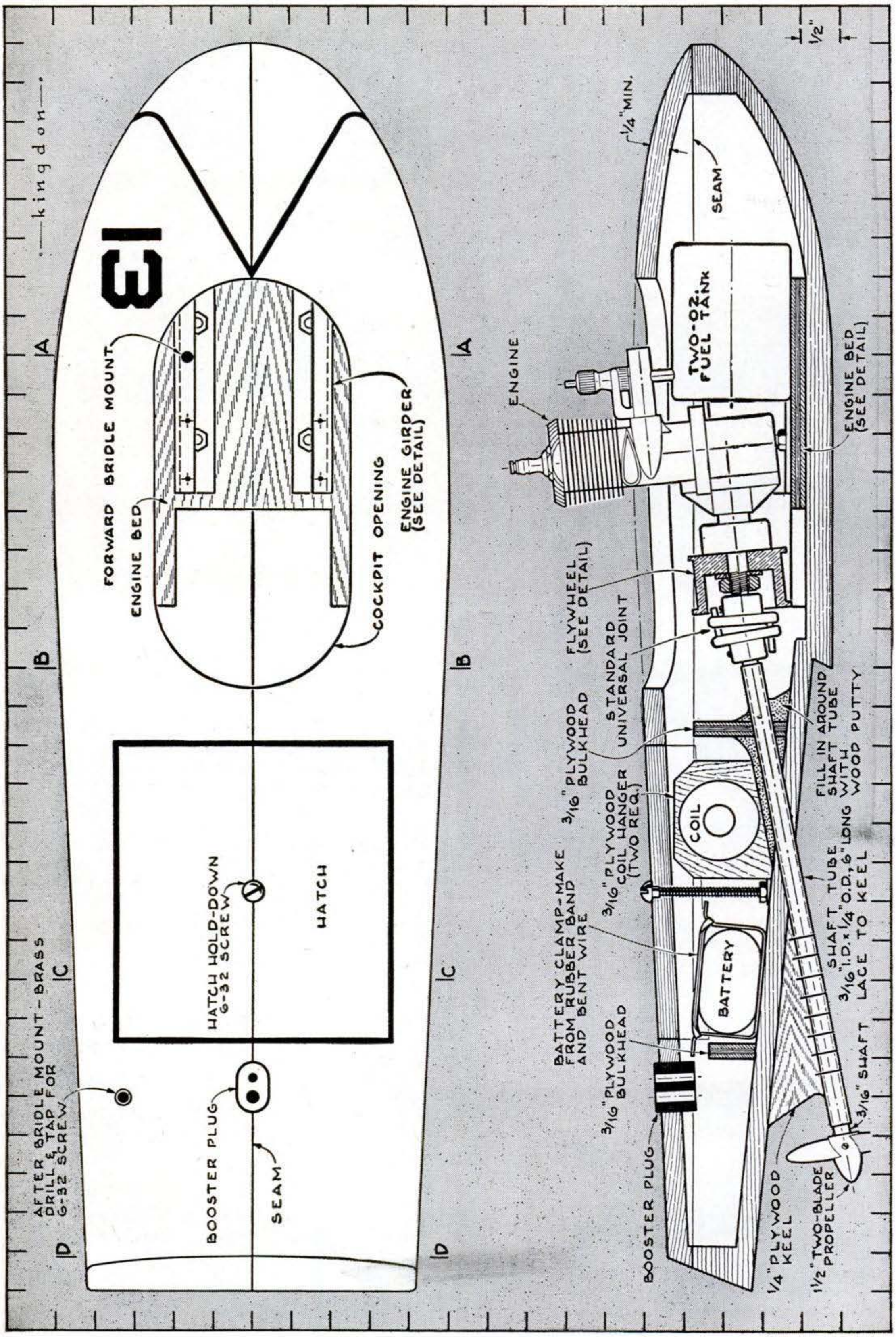

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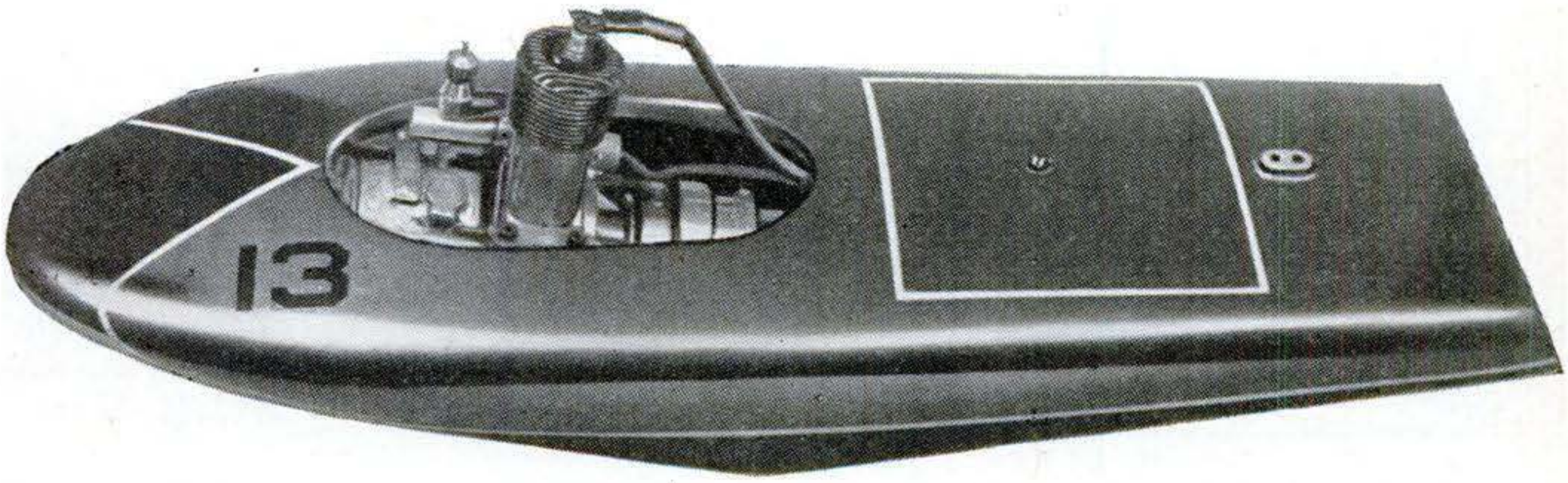
Gas Engine Planes Tiny Balsa Speedboat

An ideal beginner's boat, this racer will climb up on the step and go all out at the end of a 35′ tether line.

By Al Spampani & Kip Yandoli

For newcomers to the royal sport of building model power boats, this little speedboat is an ideal first project. It is only 16″ long, about as small as it is practicable for a boat to be and still perform respectably. Shaped from solid balsa blocks, it doesn't call for the tedious work involved in built-up or planked construction. The fittings can be made up in an hour or two in the shop, or can be purchased at a nominal cost in hobby stores. No stuffing box is required, since the top of the propeller shaft is above the waterline. The engine shown is an Ohlsson 23, but any Class B model-plane engine will be entirely suitable.

Select two ¾″ by 3″ by 16″ balsa blocks for the upper hull and two 2″ by 3″ by 16″ blocks for the lower hull. Cement the blocks together *lightly* (applying the glue at just



Compact and trim, this model will do you proud both in the test basin and on the mantel. Minor weight adjustments for best planing position are made by cementing lead scraps inside.

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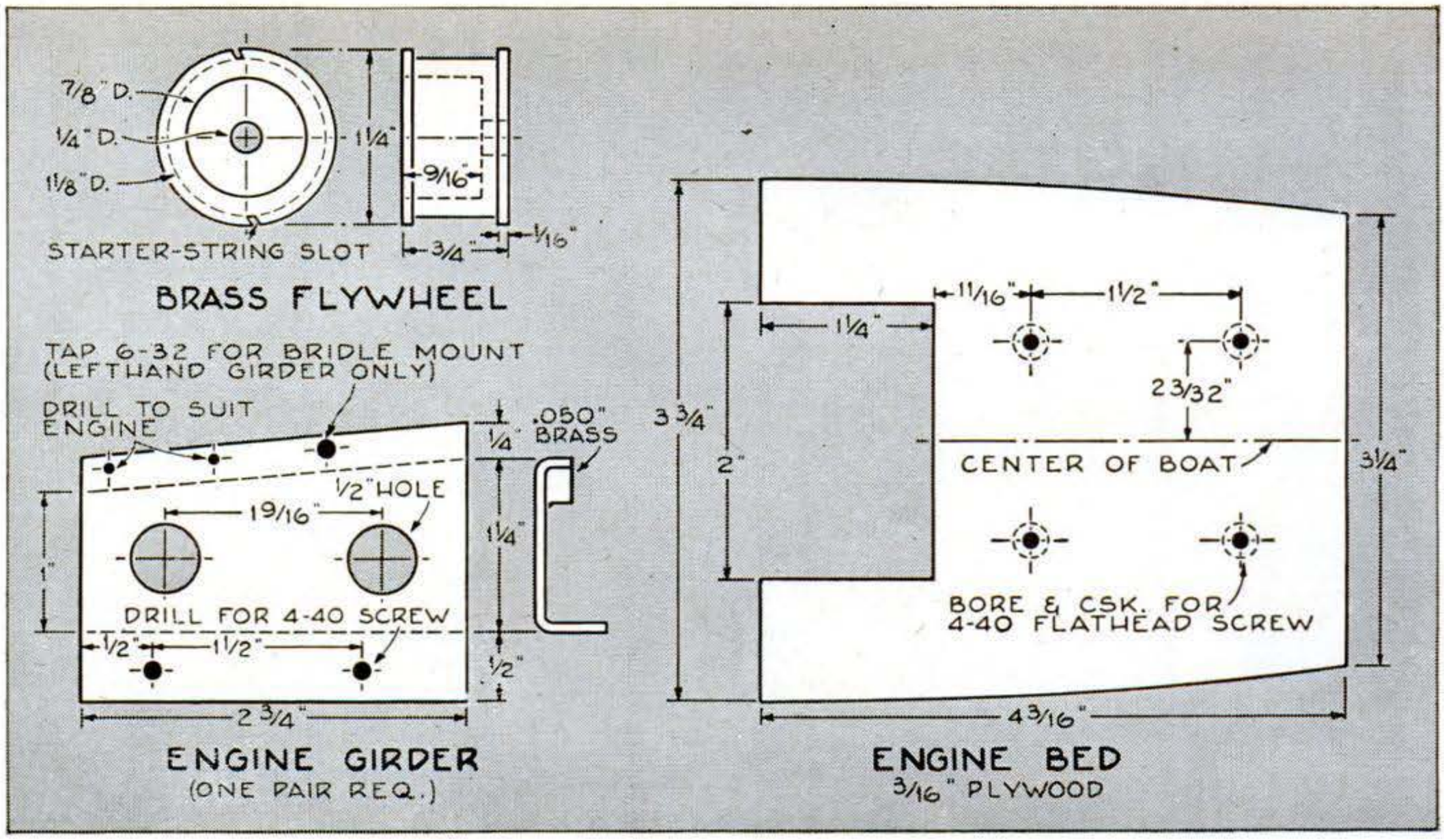
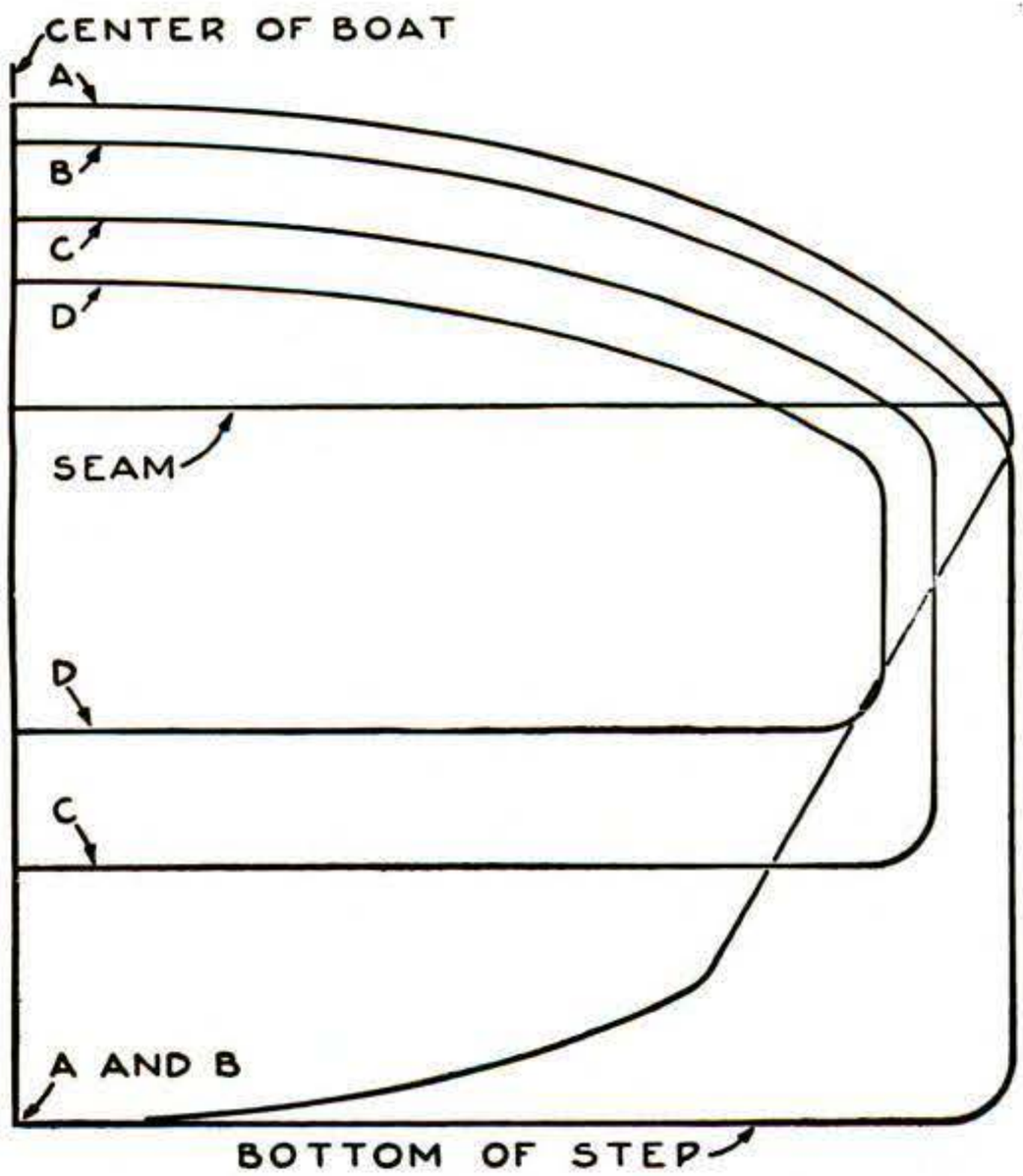


a few points), trace on the side view, and saw out and sand to the outline. Lay out the top view and cut and sand this also. Make a set of section templates from the drawing below, and with them as guides sand the hull to shape. Then separate the four blocks and hollow them out to the wall thicknesses shown. Applying cement liberally, permanently join together the two lower hull blocks and also the two upper hull blocks, but do *not* at this time cement together the upper and lower parts.



HALF-TEMPLATE PATTERNS
FULL SIZE

Coat the inside of the lower hull block with at least 10 coats of dope to insure a waterproof finish. Cut out the engine bed from 3/16″ plywood and drill holes for small bolts to hold the engine girders. The latter are bent up from .050″ or 1/16″ sheet brass and adapted to suit the engine you use. Solder two nuts to the underside of each upper girder flange to receive the engine-mounting screws; this will facilitate later removal of the engine for maintenance. Then bolt the girders to the bed and dope the latter liberally. When you have checked on the flywheel clearance and shaft alignment, cement the bed securely to the hull.

The flywheel is turned from 1¼″ round brass. In the model shown a combined shaft nut and coupling was also made from scrap brass, but if you don't have access to a metal-cutting lathe, these fittings can be purchased from model-supply houses at small cost. Cut out the triangular plywood keel, drill a hole for the shaft tube, and cement keel and shaft tube in place, taking pains to get the best possible alignment between engine and shaft. Lash the tube to the keel with strong thread, bedding the inner portion of the tube in plastic composition wood. Fit a 1½″ two-bladed racing prop to the shaft and test the assembly for free turning. If it binds at any point, minor adjustment of the coupling or engine girders, or shimming the engine on its mount, will usually correct the trouble.

Aft of the coupling, install a bulkhead to keep the ignition compartment dry. Cement

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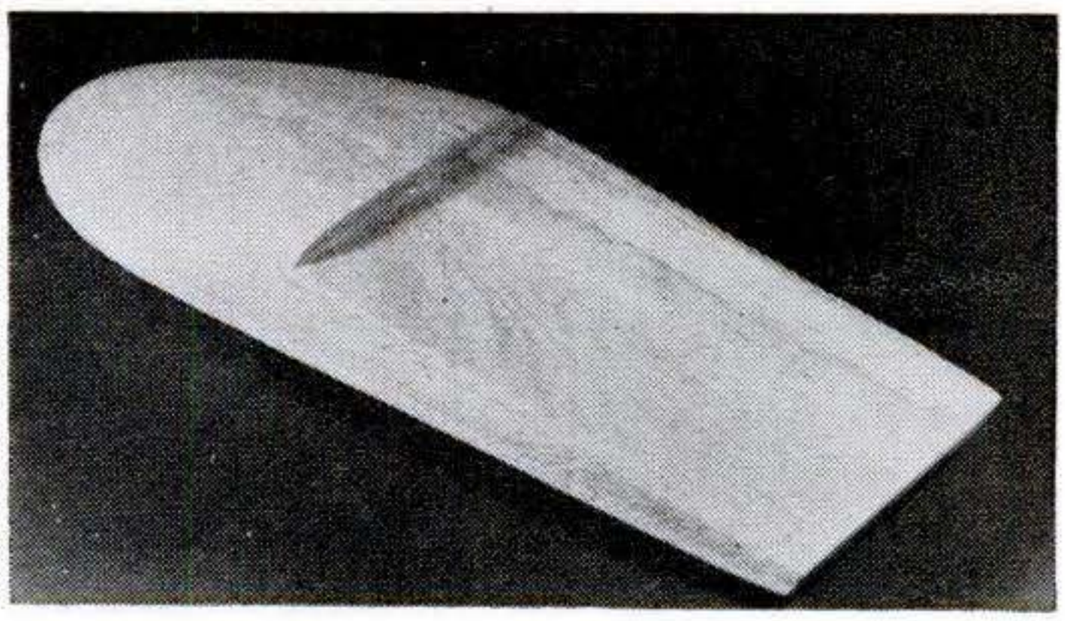

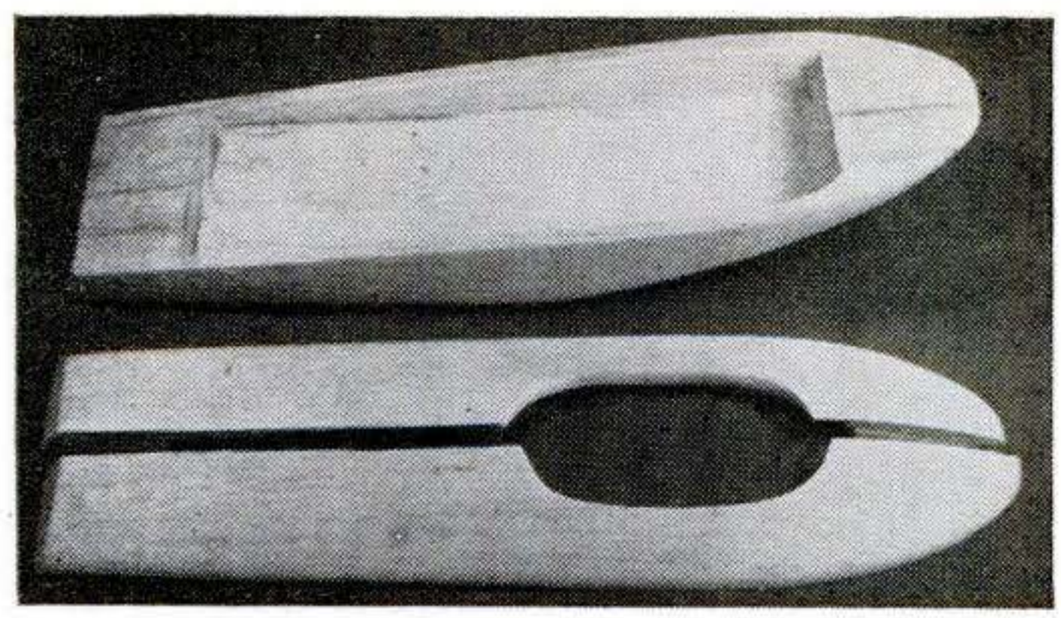

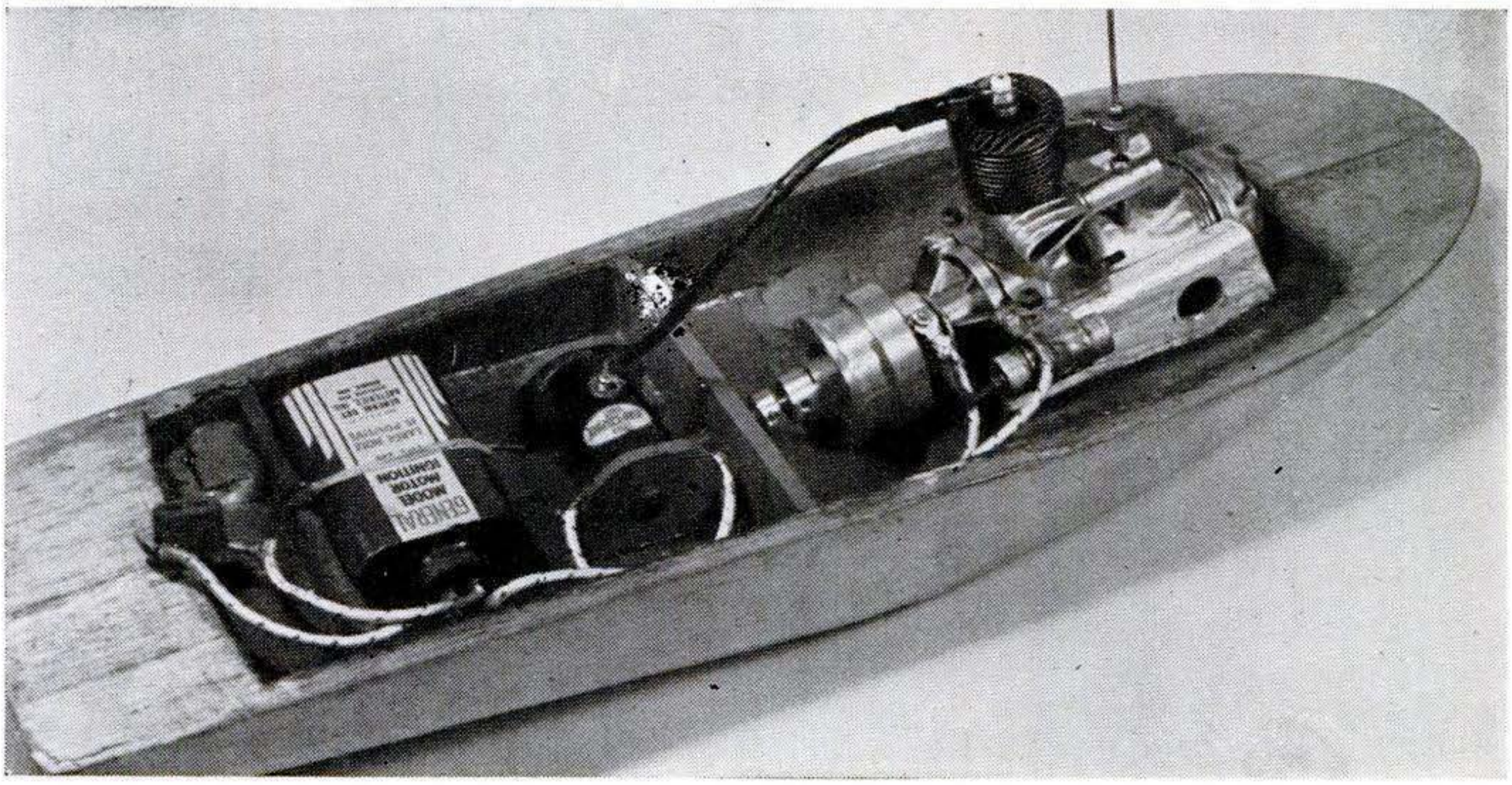

the coil supports in place, bend a battery holder from music wire, and solder up the connections for a conventional ignition circuit. Paint all wires with a few coats of dope. Install a 2- or 3-oz. fuel tank with a spring-type filler cap, and cement in the after bridle mount, which is simply a vertical brass rod tapped to take a 6-32 screw.

Returning to the top hull block, cut out the flattened ellipse to clear the engine and the rectangular hatch-cover aperture. Take pains to get a clean, snug fit to the hatch, which is retained by a 6-32 screw threaded into a nut cemented to the bottom of the hull. Dope the underside of the upper hull block liberally and cement the upper block permanently to the hull (first making sure you have clearance to remove the engine).

With the motor removed, sand the entire outside of the hull carefully, fill it with a mixture of clear dope and talcum powder, and sand until it has a glasslike finish. A light coat of lacquer surfacer is then sprayed on, and the hull gently sanded once more with No. 400 abrasive paper. At this point the original boat was sprayed with metallic maroon below the waterline and metallic blue above, separated by a white pin stripe, but of course colors to suit your own taste should be employed. Finally, give the entire hull a light coat of wax.

Make up a bridle of .015″ music wire fitted at each end with an eye to be retained by the bridle-mount screws. Attach the bridle to about 35′ of line (strong fish-line will do) and connect the other end of the line to a stake that can be driven into the bottom of the pond. Provide a central pivot that will prevent the line from winding up on the stake. With all running gear secured, fill up the fuel tank, plug in the booster batteries, and start the engine with a starting cord wound around the flywheel. Adjust the mixture and spark until the engine is running properly and then hold the boat in the water and readjust to correct for the increased propeller load. When she's running right, let 'er go.

After a turn or two, with a properly adjusted engine and bridle, the boat will climb up on the step and really move. Then your chief worry will be shooing off neighborhood dogs that take the boat for a seagoing rabbit END

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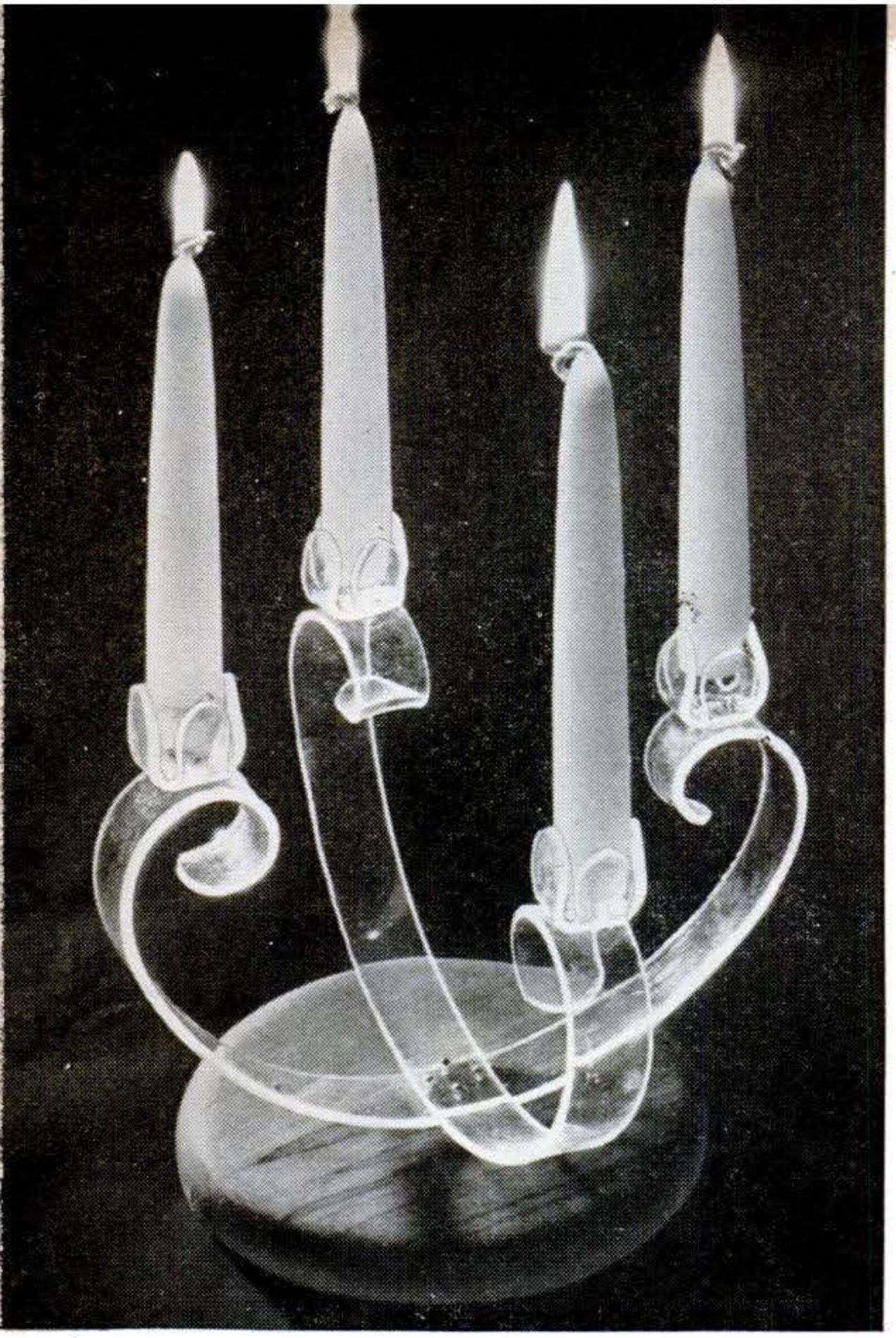
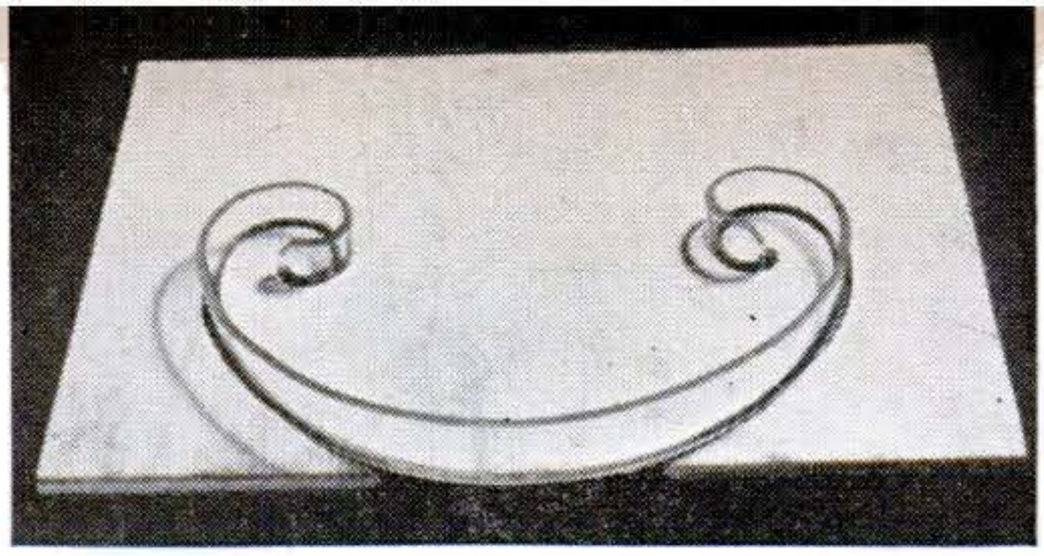
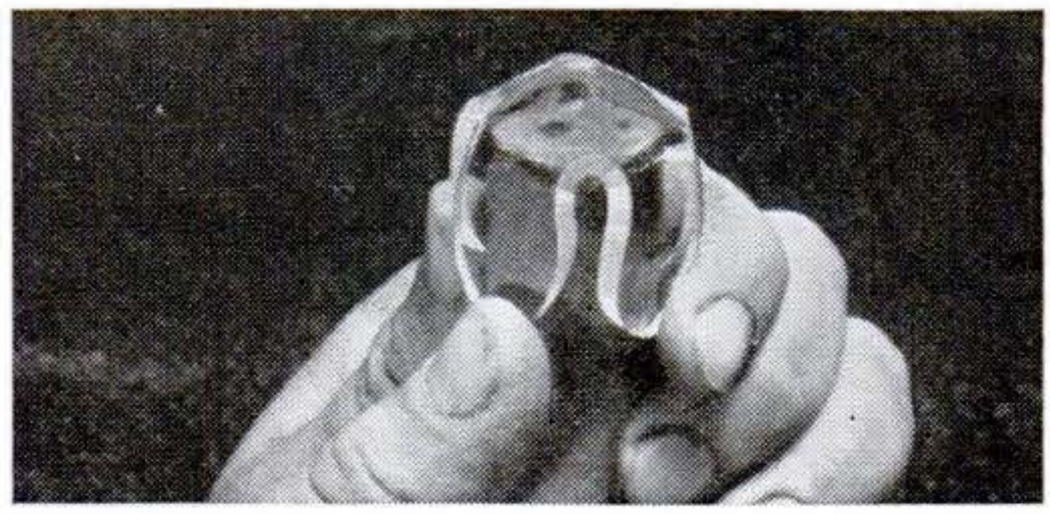


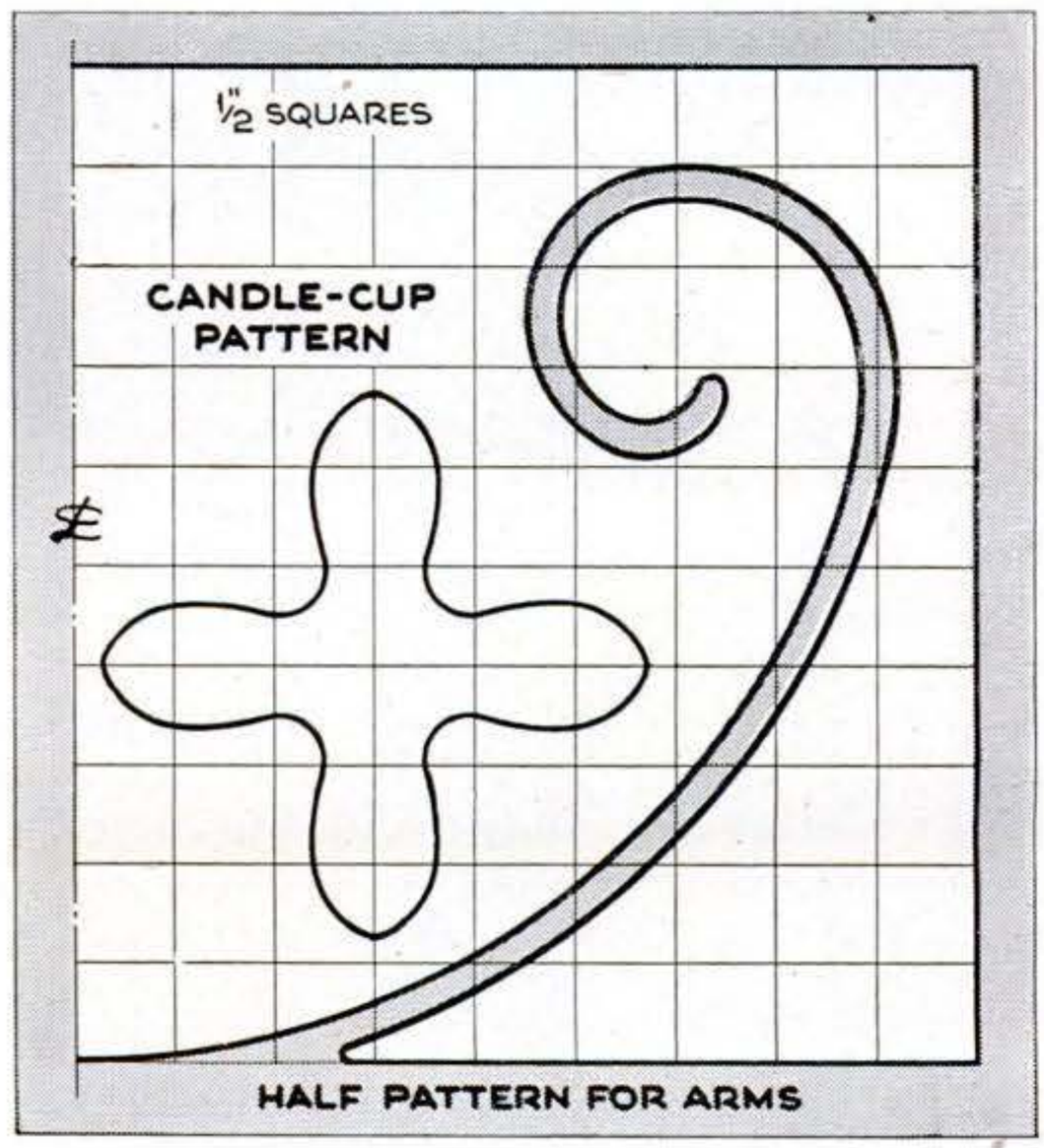
The polished edges of the candelabra pick up and reflect the dancing gleam of the candle flames.



Shape the arms by pressing heated plastic strips into a form that has been cut out of scrap wood.



The candle cups are cut according to the pattern below, then heated and bent over a ¾″ dowel end.



Make the channel for the arms a bit wider than ⅛″ so that the heated plastic will slide in readily.

Clear Plastic Sparkles in Candlelight

By Elma Waltner

GLEAMING plastic arms curving above a satiny hardwood base will add a note of beauty to your dinner-time candlelight. For the base of this crystal-like candelabra, turn a piece of gum or walnut to 7″ diameter and round off the top. Polish and wax the wood while it is still in the lathe.

Two strips of ⅛″ by ¾″ by 18″ clear plastic are used for the arms. They are formed in a jig cut from scrap wood. The pattern shown is for only half the jig, which should have two scrolls. Round off the ends of each strip, heat it to about 250 deg. in an ordinary oven, and quickly fit it into the form.

Cut the candle cups according to the pattern shown and form them over the end of a ¾″ dowel. Place the arms together at right angles, drill four small holes where they cross, and drive brass-plated escutcheon pins through the holes into the base. The candle cups may be cemented to the arms or held by aluminum rivets, which won't be noticed under the candles.

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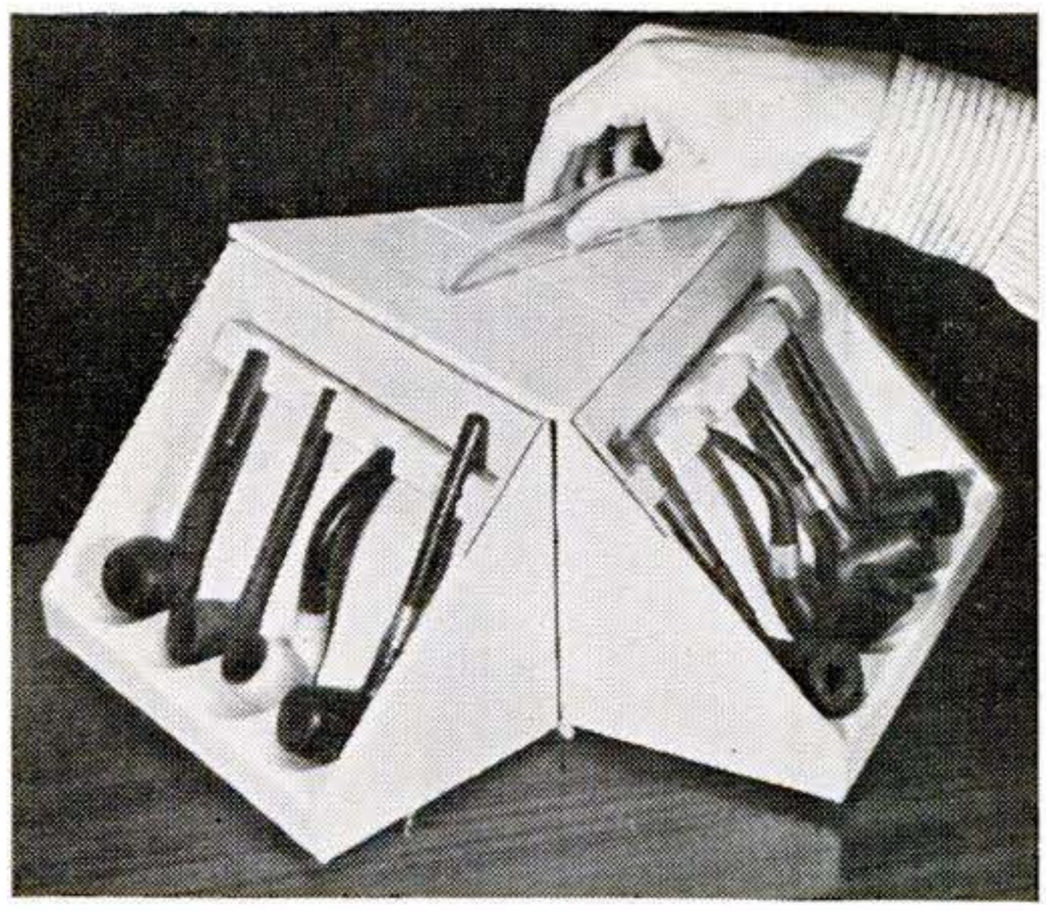
Pipe Smoker's Cabinet Holds All Accessories

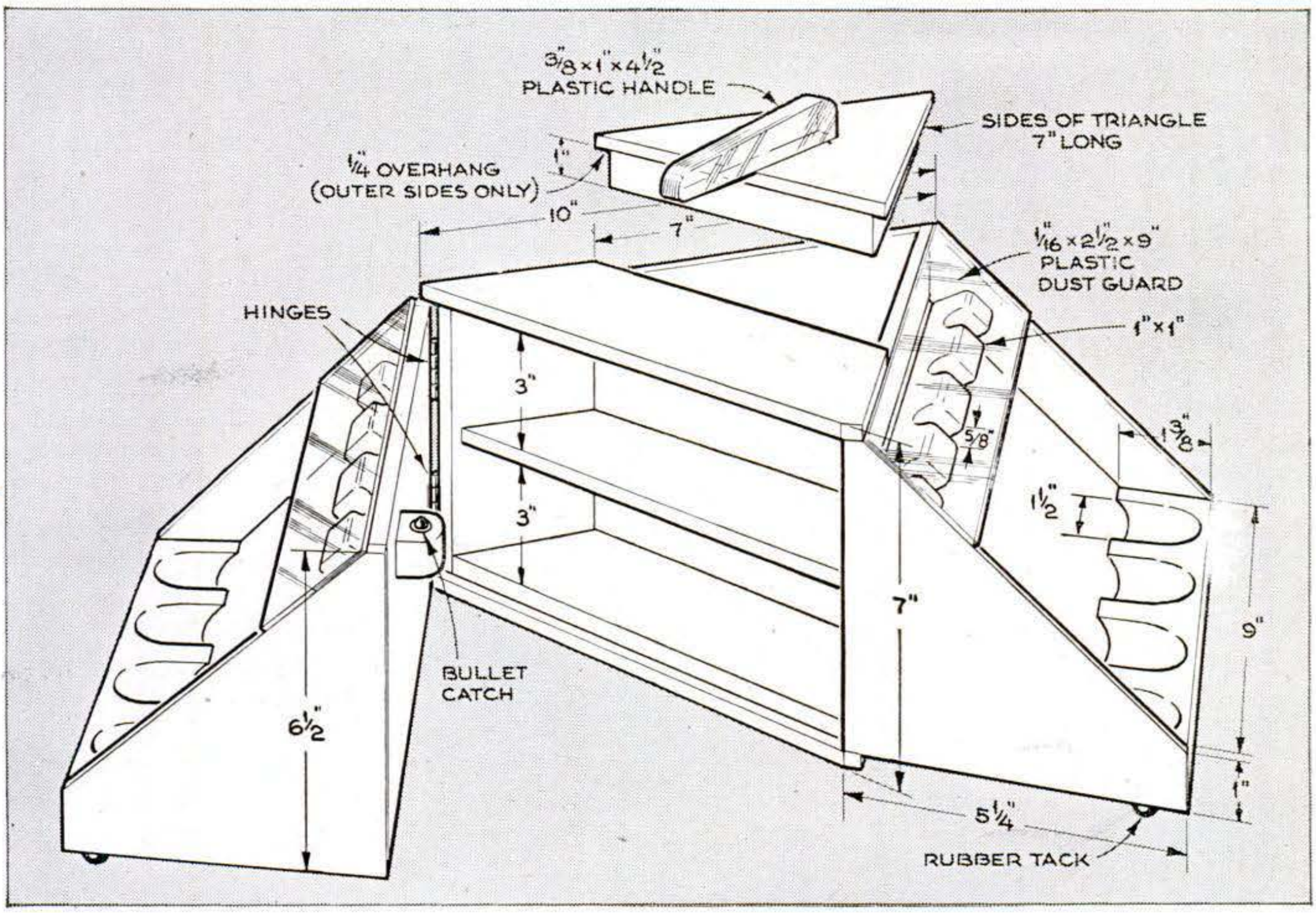
FOR THE smoker who is tired of cylindrical humidors, here is a man-size combination cabinet that holds plenty of tobacco and has racks for eight pipes. In addition, one of the racks is hinged over two shelves with room enough for a carton of cigarettes and a dozen papers of matches.

If mahogany, walnut, or some other appropriate hardwood is used for the cabinet, the finish should, of course, be natural to show the grain and color of the wood. White pine or other softwood will do, however, and may be enameled or lacquered in color. As an added touch, you can line the tobacco compartment with a veneer of cigar-box cedar, also available as Spanish cedar. In this event more than the specified ¼" overhang should be allowed on the lid so the bottom part will fit inside the veneer lining. A porous-clay humidifier may be inserted in the lid to keep the tobacco moist.

Cut the pieces to size and assemble with waterproof plastic glue. Brads may be substituted for clamping if the piece is to be painted. The two blocks for the pipe stems may be made as one piece, drilled with ⅝" holes, and sawed through the center. Shape the blocks for the pipe bowls with a half-round wood rasp or gouge. The base may be a single piece ½" thick rabbeted to take the sides, or two ¼" pieces may be glued together. Clear-plastic or glass strips cemented across the tops of the pipe racks will keep dust from settling on the stems of the pipes.—ROLAND CUEVA.



Its triangular shape will let the humidor be placed against a wall on a table or bookcase. All work on it can be done with hand tools.



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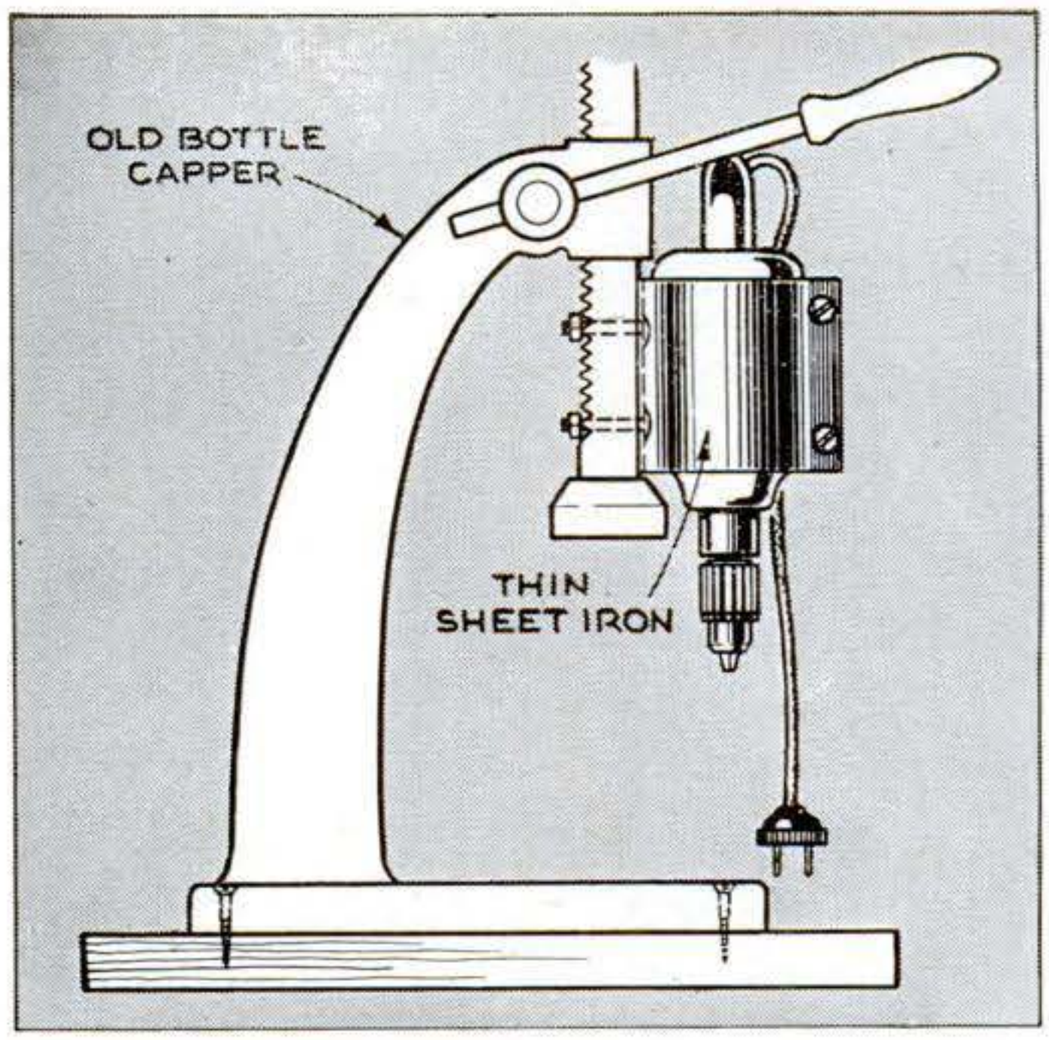
Old Bottle Capper Serves as Improvised Drill Press

WANTING to drill a large number of holes at 90 deg. to the work surface, and having only an electric drill with which to do it, I improvised a drill press from an old bottle capper.

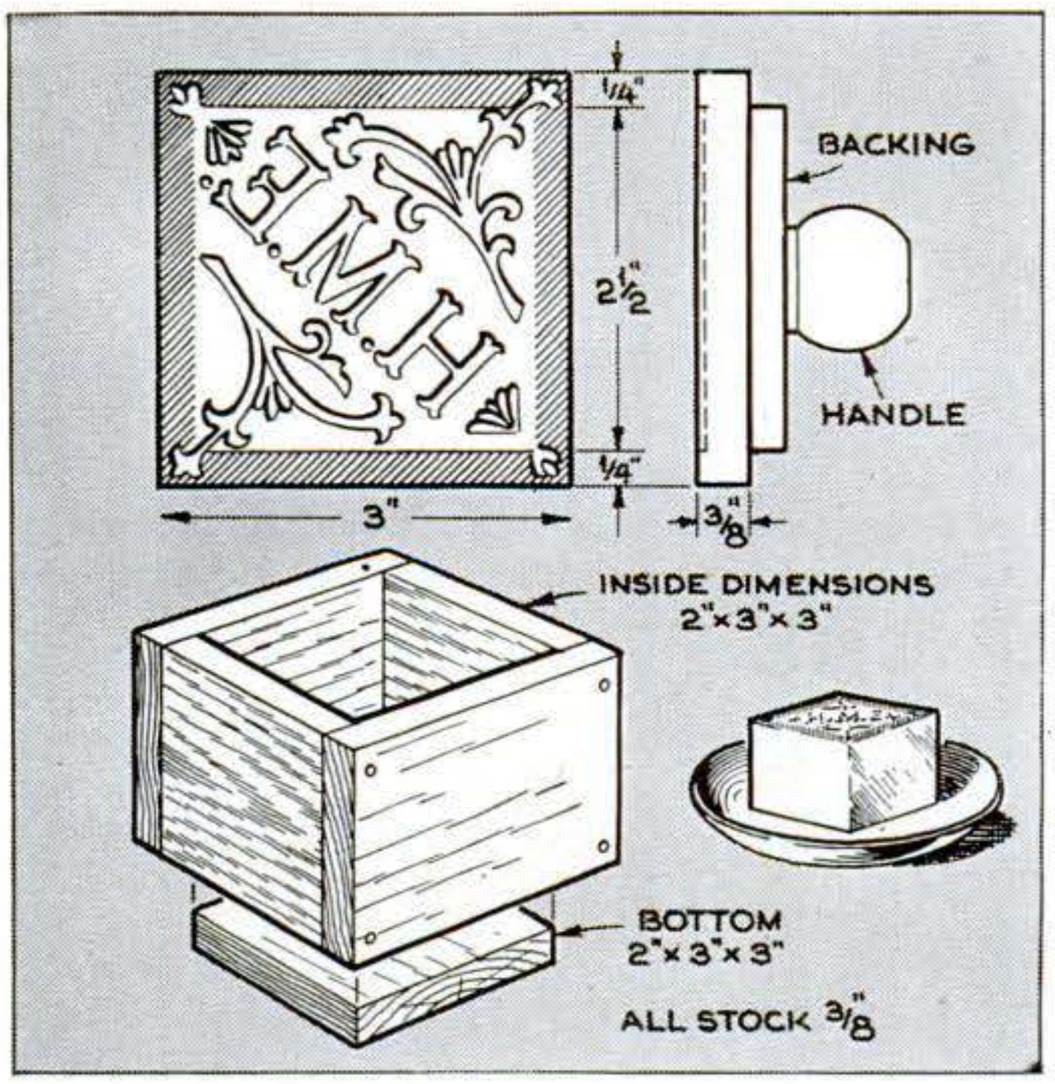
After first drilling two holes through the shaft of the capper, I bolted on a piece of sheet metal. This was bent into the form of a circular clamp and bolted around the body of the drill. Small work was laid on blocks, which raised it within easy working distance of the drill chuck. The arrangement proved to be extremely satisfactory for many types of drilling that did not require extreme accuracy.—IVAN L. CHURCH.



Molds Make Butter and Other Table Spreads More Attractive

TABLE decorations can make mealtime pleasanter, and by that fact alone increase the value of the food you eat. Butter and its substitutes, for example, are more attractive when molded into neat pats topped with appropriate initials or designs.

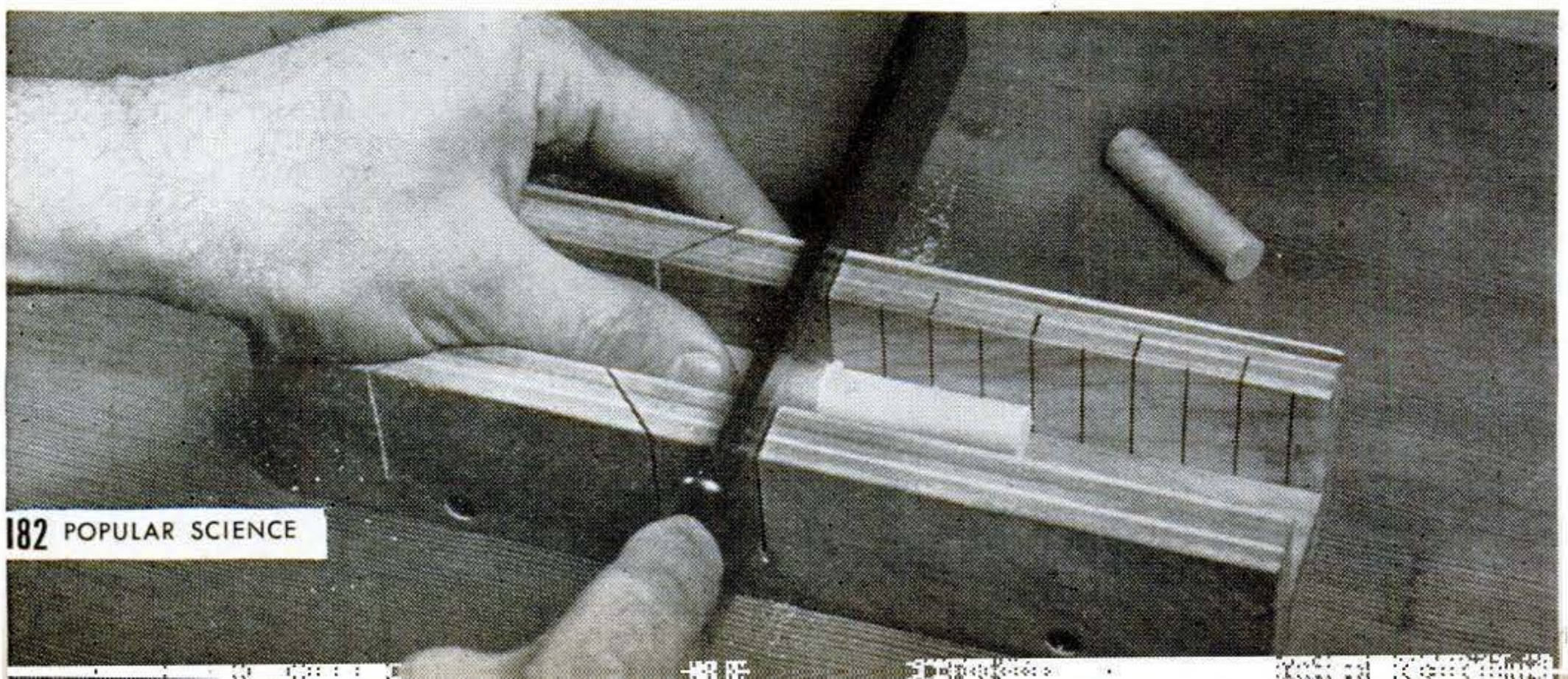
The mold shown at the right is one of many possible varieties; its dimensions are suitable for about a half pound. Bottom and top blocks fit inside the frame. Hardwood is desirable for all parts and particularly for the top, in which the design is to be carved. To use, dip the mold in cold water, fill it with slightly softened butter, margarine, or the like, and press down on the handle to shape the spread and impress the design upon it. When molded, lift off the top and sides.—R. H. JENKINS.



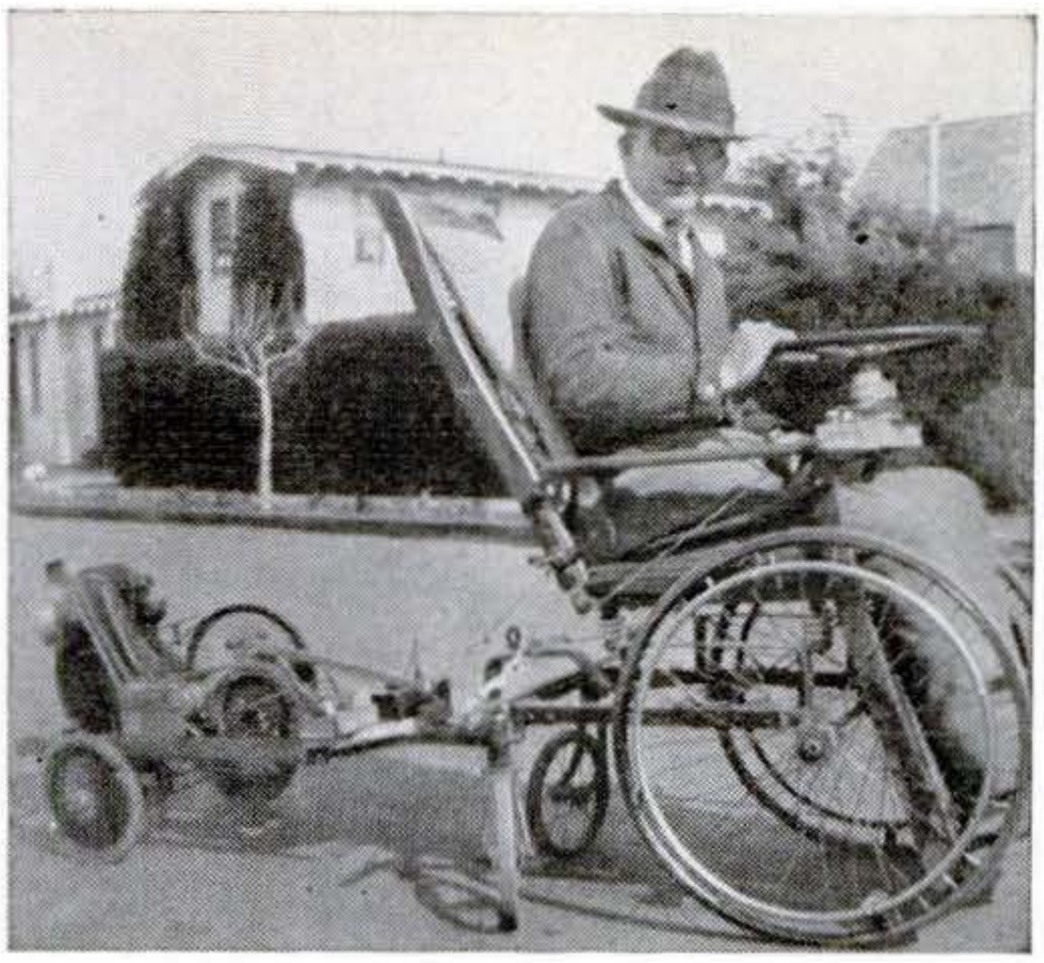
The separate bottom makes it easy to remove the pressed butter and also to clean the mold.

Index Lines in Miter Box

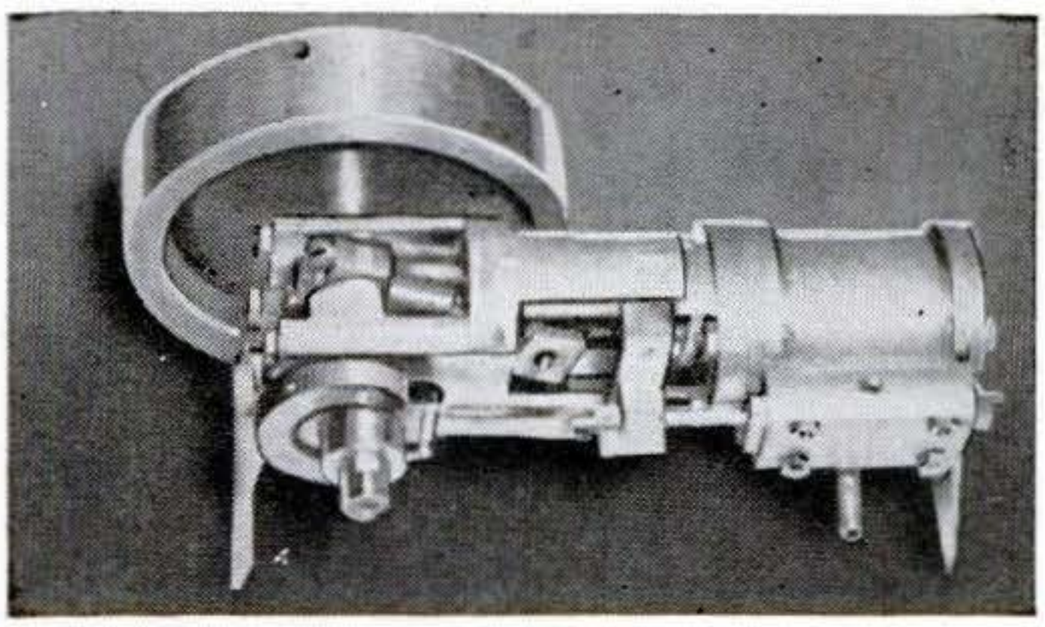
LINES ruled at fixed distances inside a miter box make it a quick and easy job to cut short pieces of stock to any given length. The index marks shown in the photo below are spaced ½", but the intervals can be made shorter or irregular as may be required. They are equally useful for straight or miter cuts.—GLENN A. WAGNER.



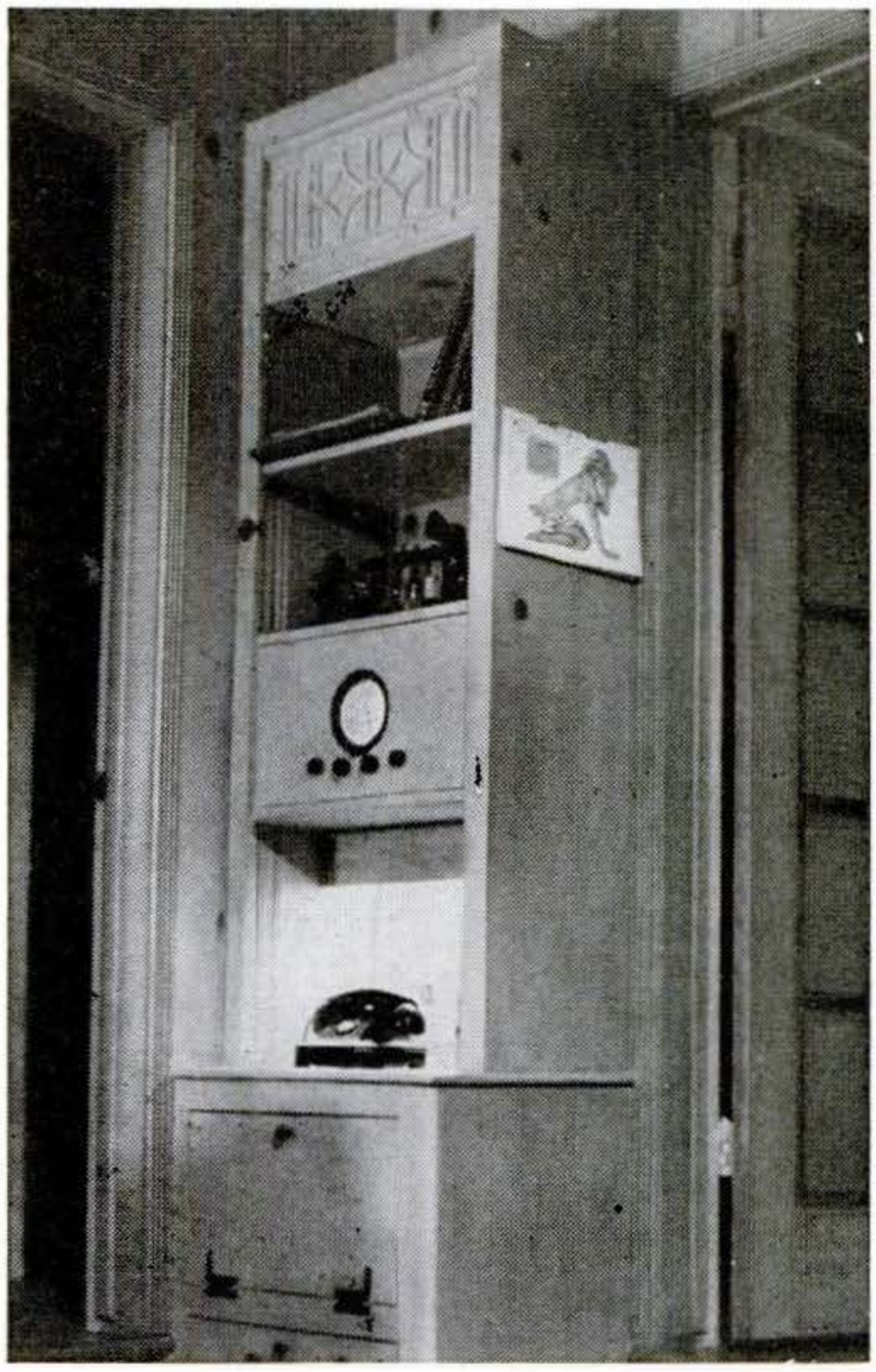
CRAFTSMEN at WORK



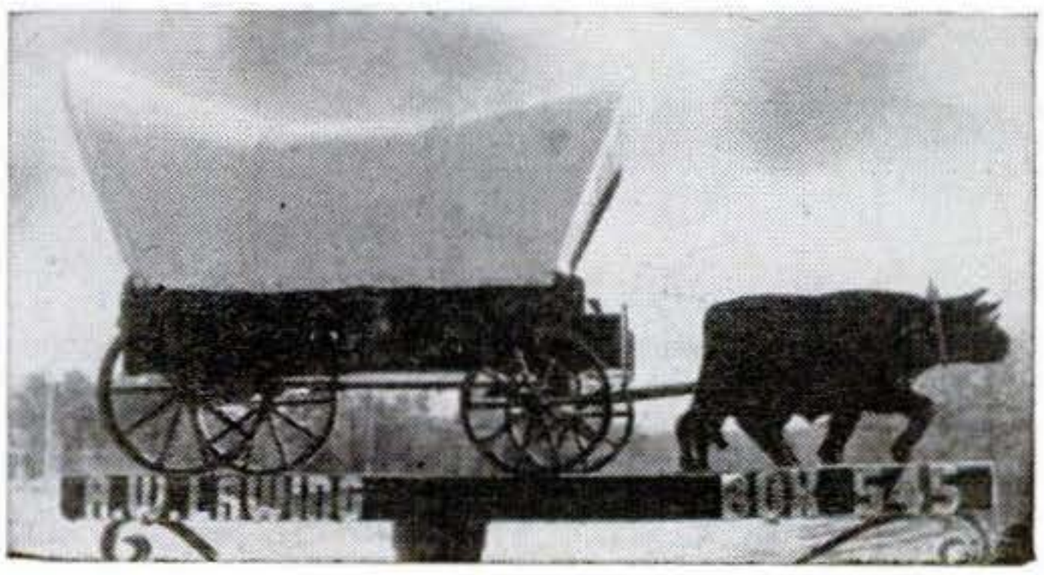
Wheel Chair Has Motor. R. H. Hamrick, of San Leandro, Calif., connected a ¾-hp. Briggs & Stratton motor to the rear of his wheel chair to save energy in traveling the two miles from his home to the shopping district. A lanyard is run back to the clutch (taken from a motorcycle), and a wire controls the throttle.



Steam Engine from Warplanes. Part of an aluminum propeller from a Zero was turned for the crank mounting of this 7½" long, one-cylinder model steam engine. The crank bearings are miniature ball bearings from a Betty bomber. All other parts are brass. Virgil L. Spaur, of Narrows, Va., built the engine while in the Navy.



Radio Built into Corner. The small corner space between the doors of his den was utilized by Ed Sheldon, of Burbank, Calif., for his radio, record player, and telephone. He installed them in a built-in cabinet. The speaker is on the top shelf, two shelves are for record albums, and the radio is behind a panel on the lowest shelf. A bottom-hinged door below the phone counter conceals the record player.



Covered Wagon Takes Mail. This is a miniature covered wagon, but it has made a 6,000-mile trip—from Hawaii, where it was built by William J. Lawing while he was a draftsman at Pearl Harbor, to his home in Charlotte, N. C. It was made entirely of brass, and the top was then covered with canvas. Spokes were brazed to the turned wheels. The back is hinged to let the wagon serve as a rural mail box.

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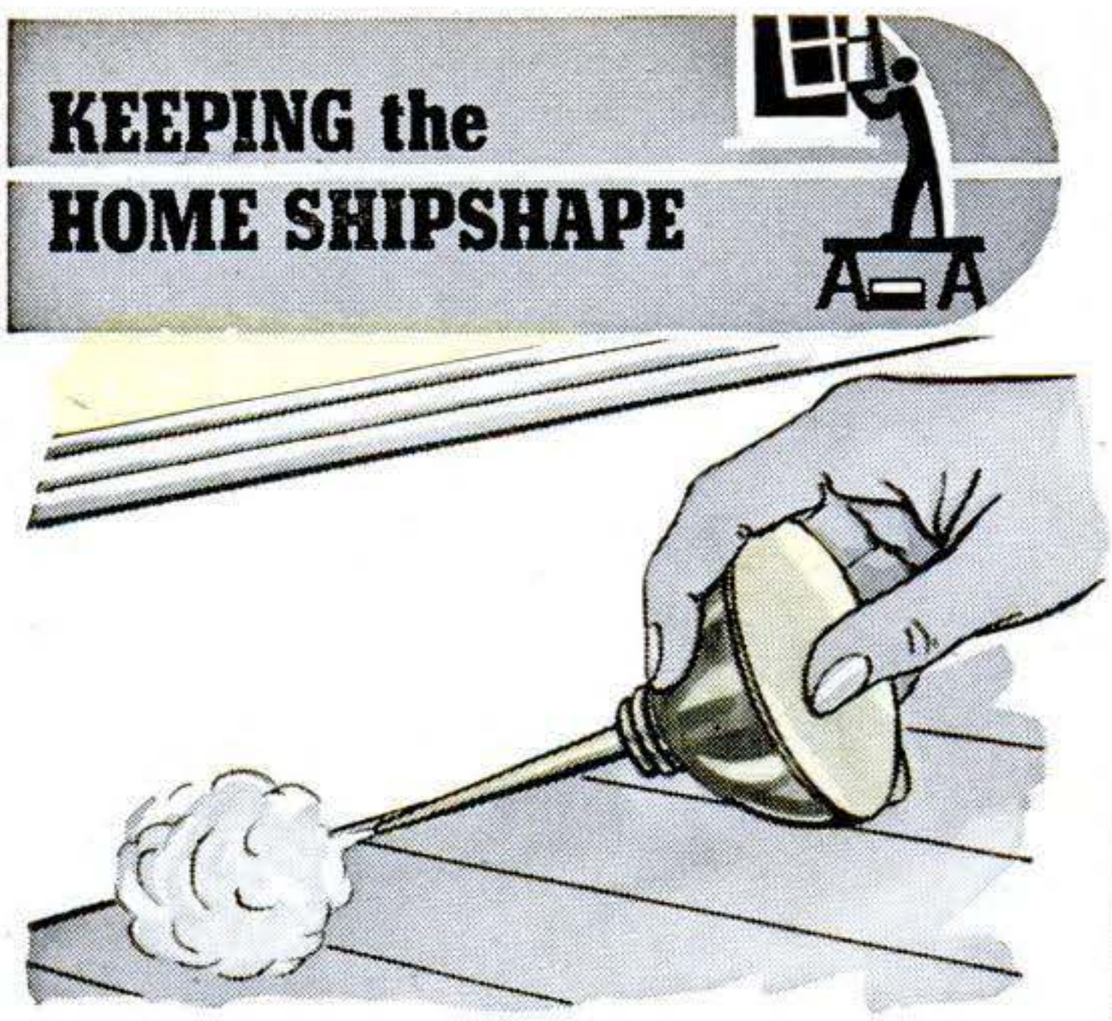
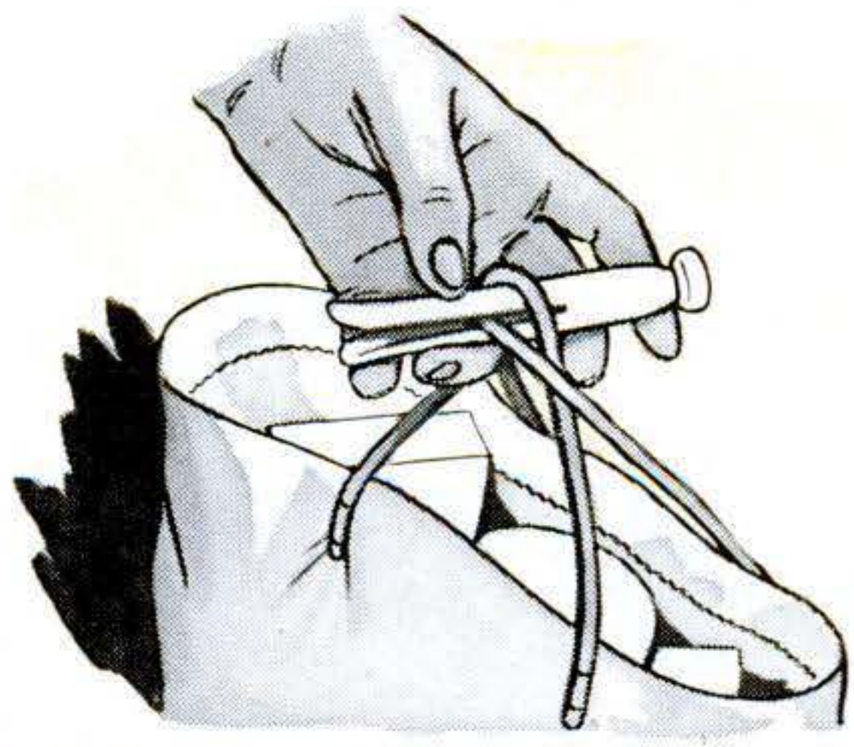
KEEPING the HOME SHIPSHAPE

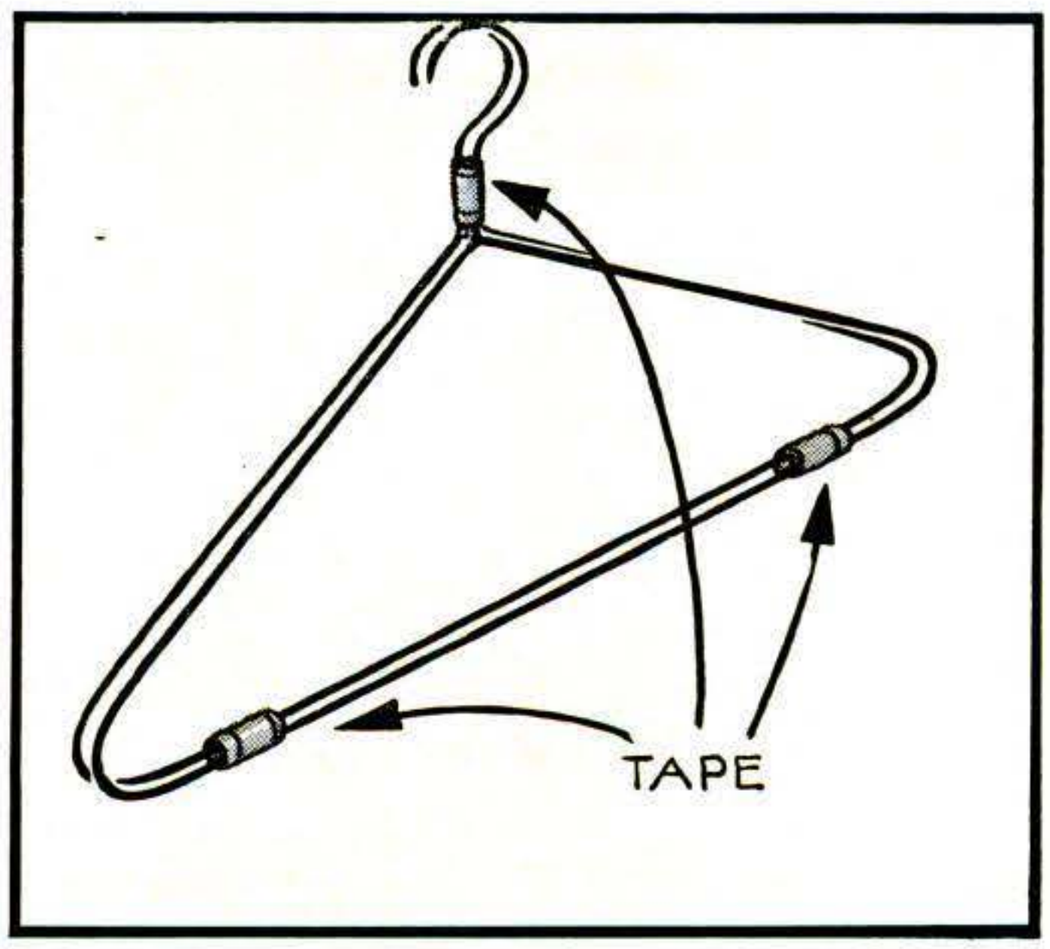


Use an ordinary oilcan to squirt insect powder into moldings, cracks, and crevices. If the spout becomes clogged, tap the can on a hard surface.

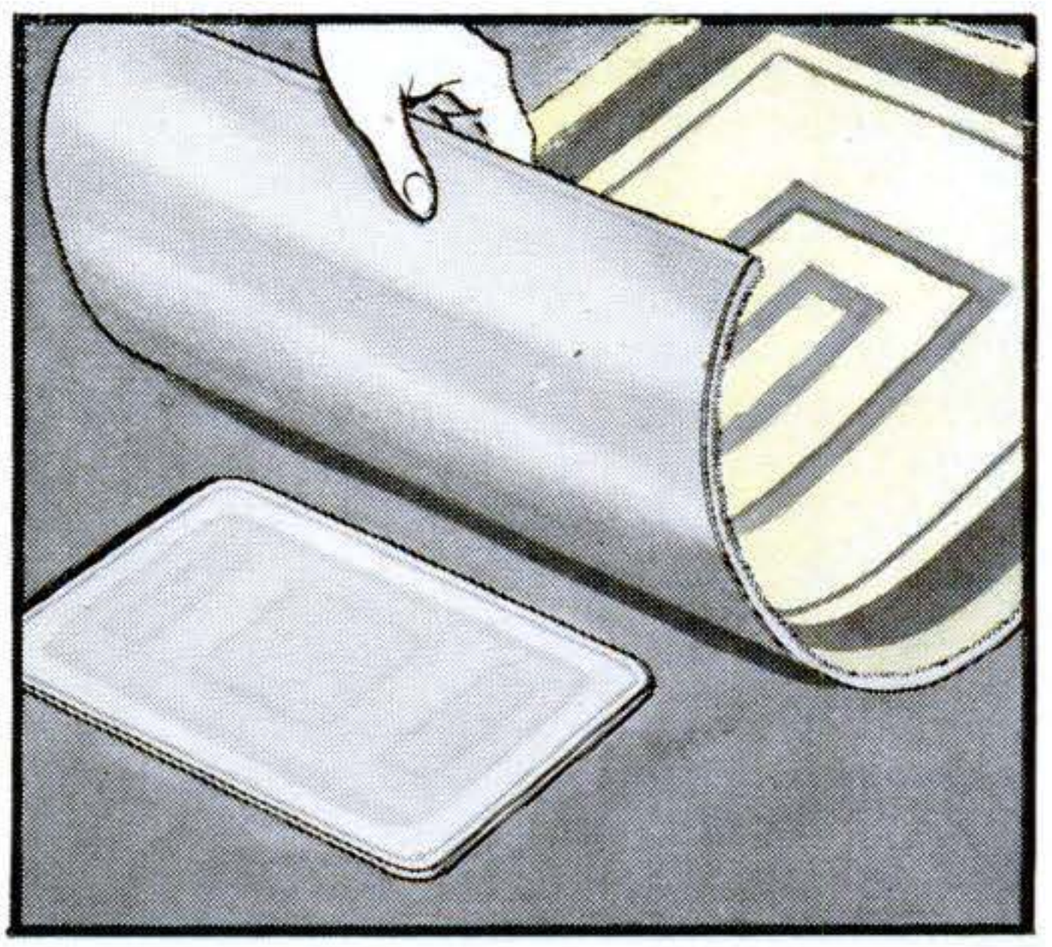
To mount flowerpots on a wall or window frame, bend brackets from ¼" copper tubing as shown. Rub the metal bright and lacquer it.



If the handles of a shopping bag cut into your hand, slip a clothespin through the cord loops. When not in use, keep the pin in the empty bag.



Do wire coat hangers cave in under the weight of your heavier garments? You can make them twice as strong and useful by binding two of them together with cellulose or adhesive tape.



Scatter rugs that have a tendency to slip and slide on polished floors can be made to hold their ground better if an old rubber bath mat or dish-drain mat is placed under each rug.

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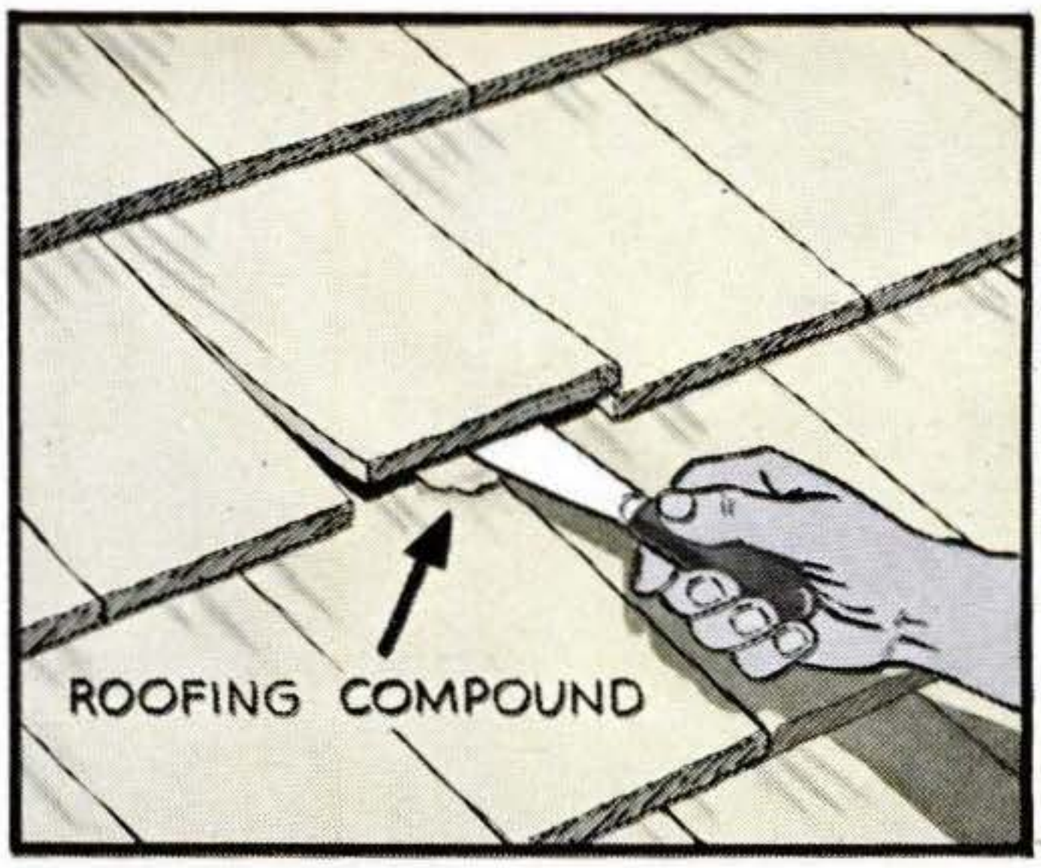
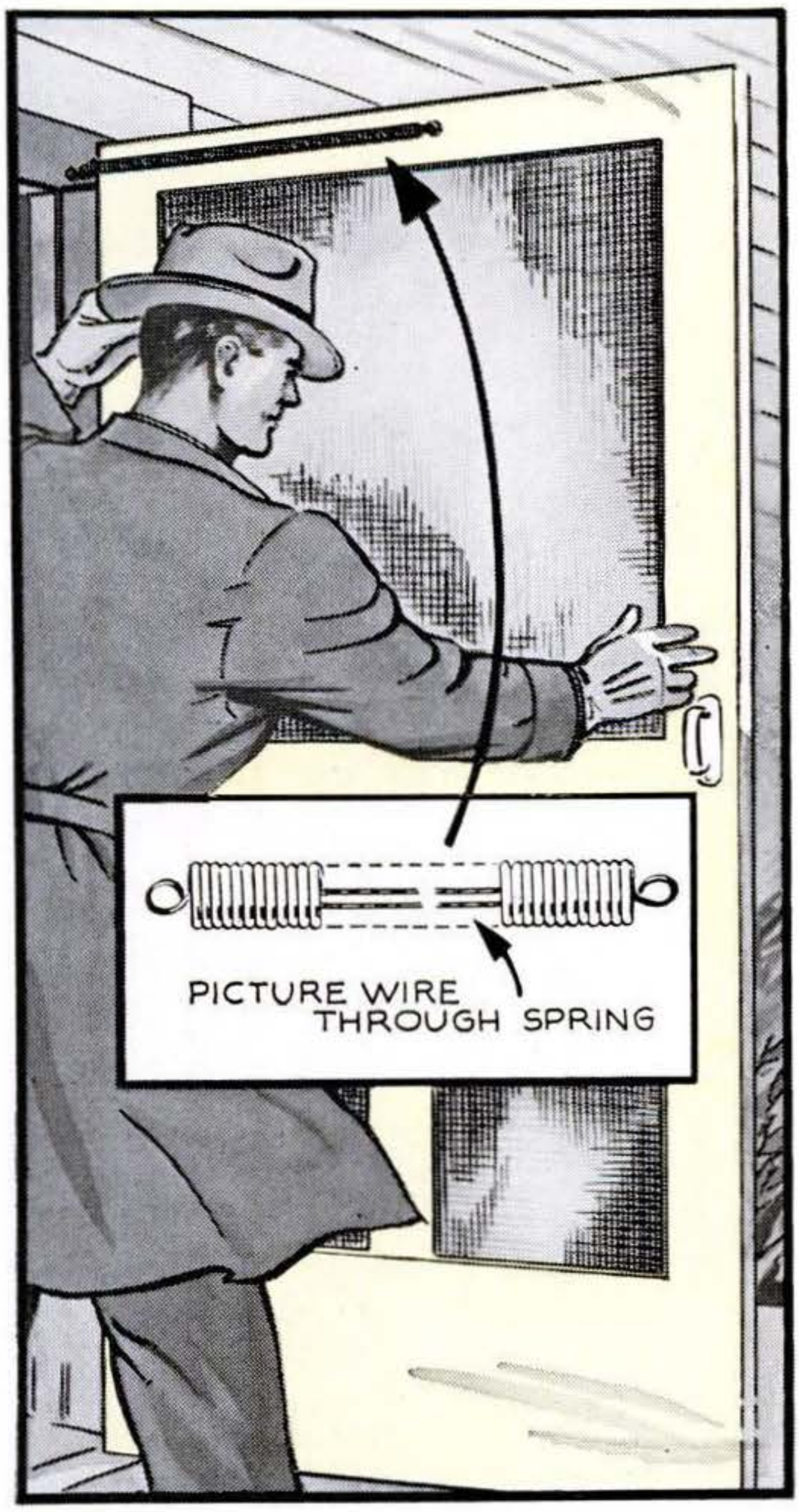
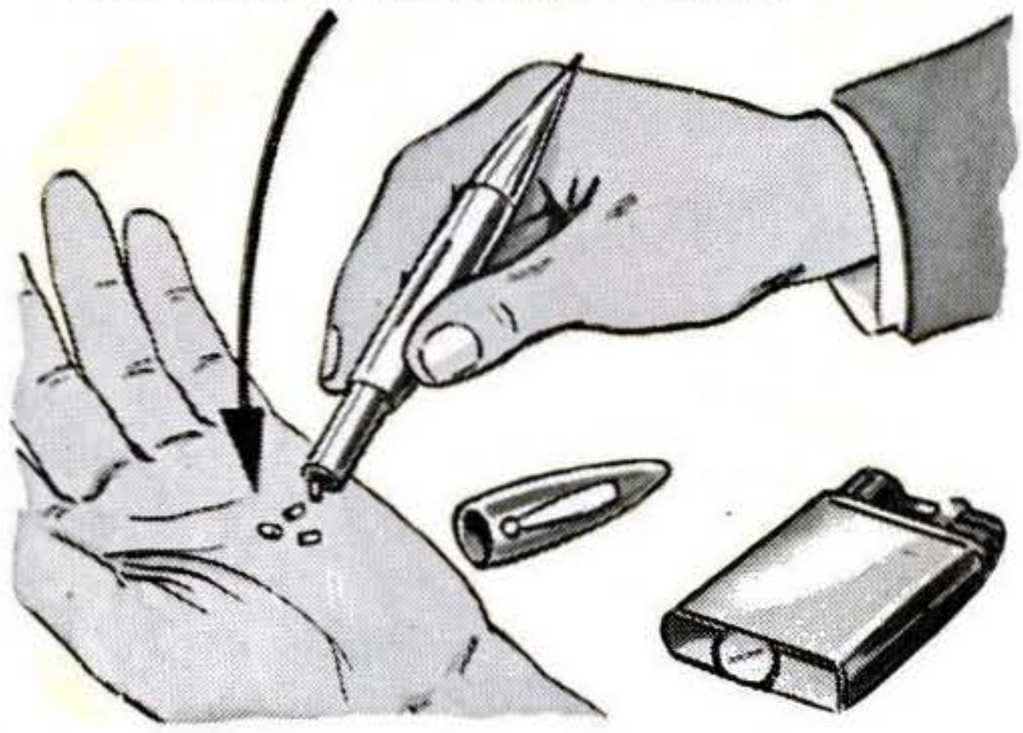


Wind and driving rain often combine to force water under shingles. A dab of roofing compound under each shingle will seal it tight.

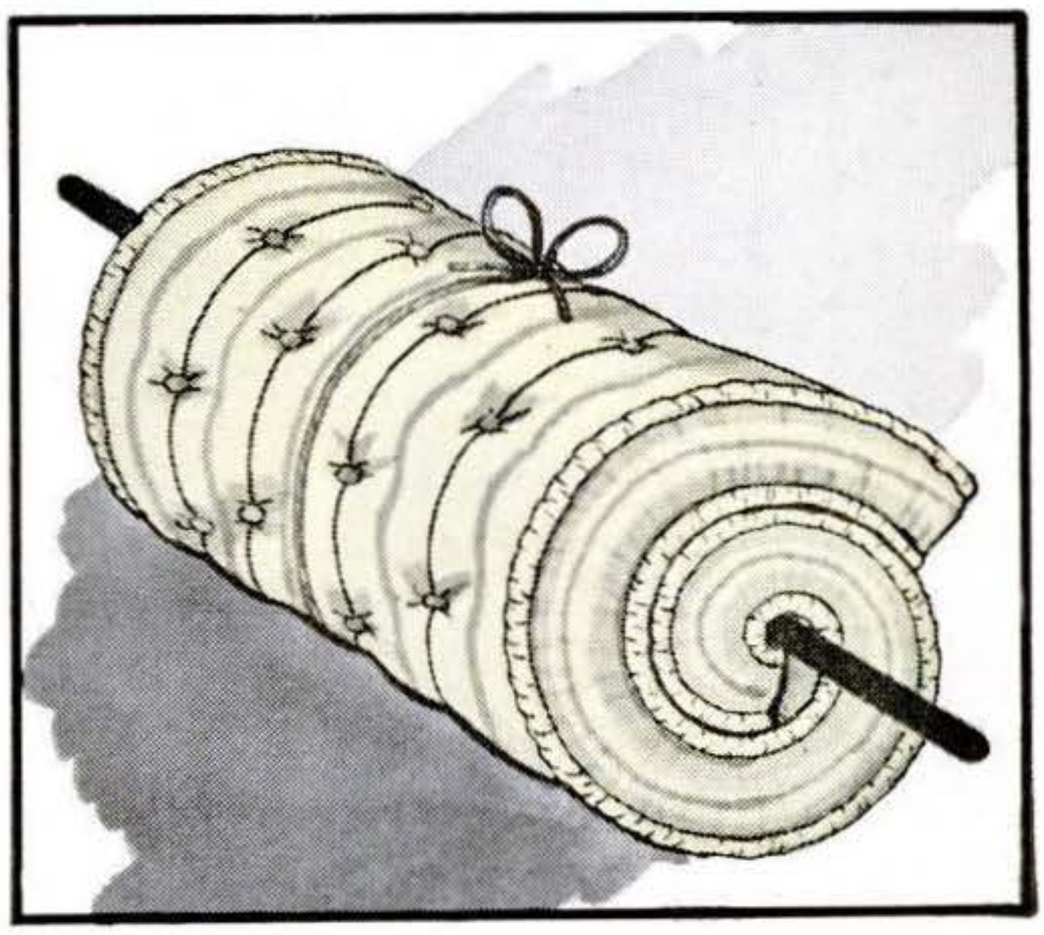
Kitchen paint will stay fresh longer if you leave a window slightly open at all times to provide a ready escape for steam and moisture.



Flexible picture wire strung through the spring will limit the travel of a screen door and prevent damage that might otherwise be caused by a heavy gust pulling the door violently open.



If your cigarette lighter has no provision for carrying extra flints, store a reserve supply in the lead holder of your mechanical pencil.



A cumbersome mattress may be carried easily by two people. Loop a string around it and draw it into as tight a roll as possible. A closet pole through the center provides fine handles.

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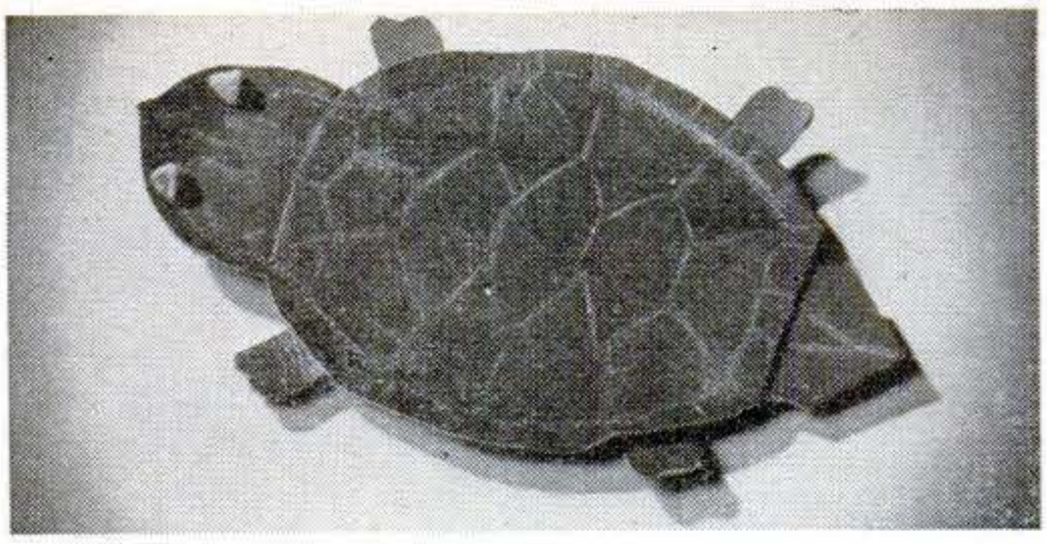
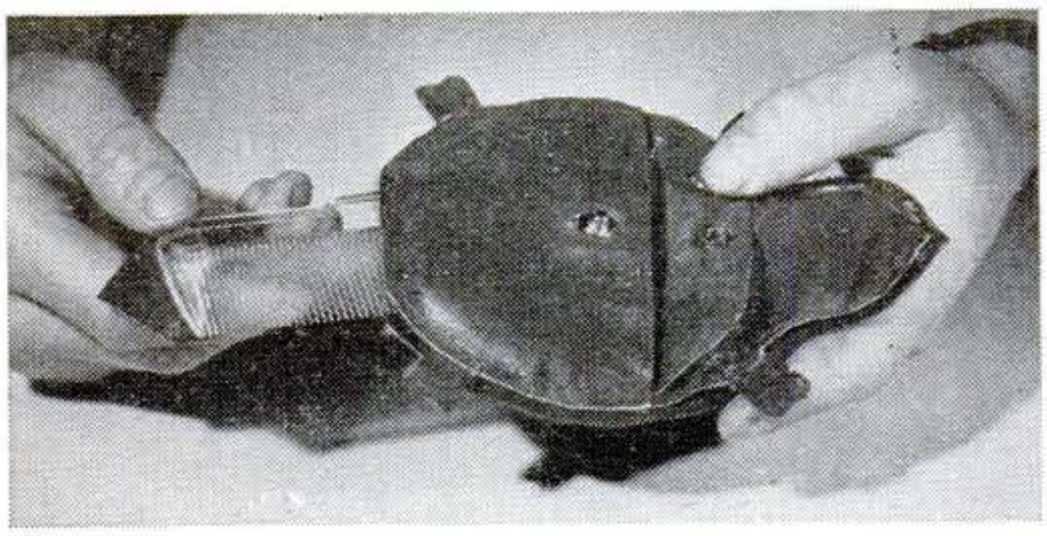
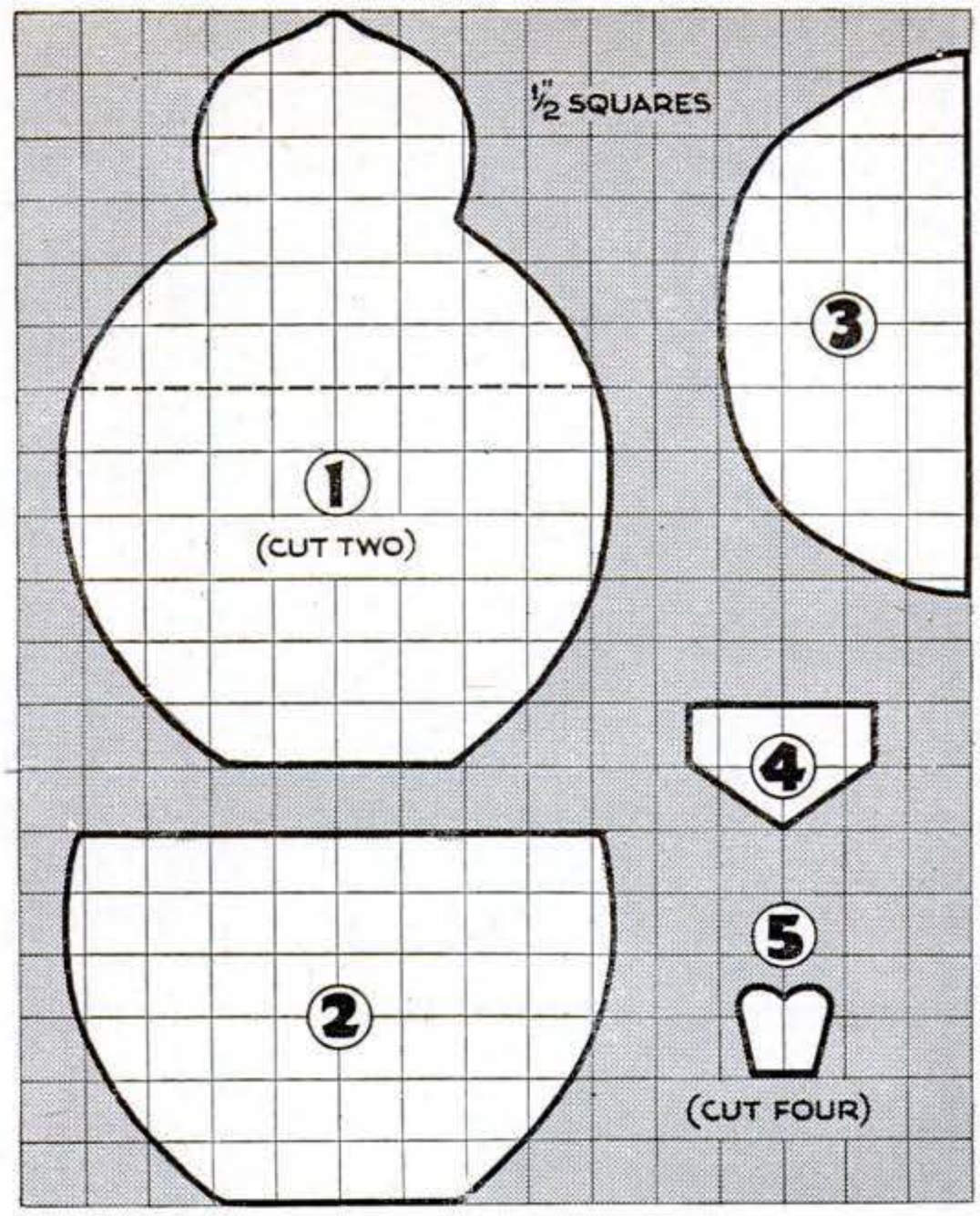


Painted markings make this combination comb case and coin purse look much like a real turtle.



The tail forms a handy tab for pulling out the comb. Note the snap fastener on the purse.

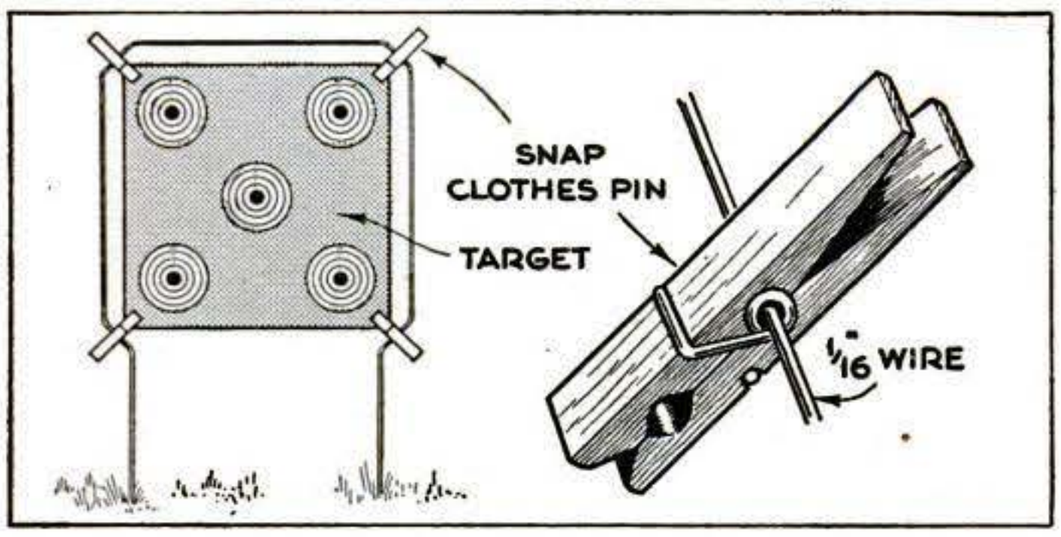


Turtle Case Holds Both Change and Small Comb

CUT in the shape of a turtle, this combination comb case and change purse will make a particularly welcome gift for a woman or girl addicted to having everything helter-skelter in her handbag. It may be made from either felt or leather.

After cutting out the pieces, begin the assembly by stitching part 3 (the flap of the purse) to one piece of part 1 on the dotted line, leaving a narrow seam along the straight edge of part 3. Then sew part 2 (the body of the purse) to part 1 below the dotted line, leaving the top piece of 2 unstitched. Put parts 5 (the legs) in place and sew the two parts 1 together around the edge, leaving the base open to receive the comb. Cement part 4 (the tail) to the comb and install a snap fastener on the purse.—B. V. HENDERSON.

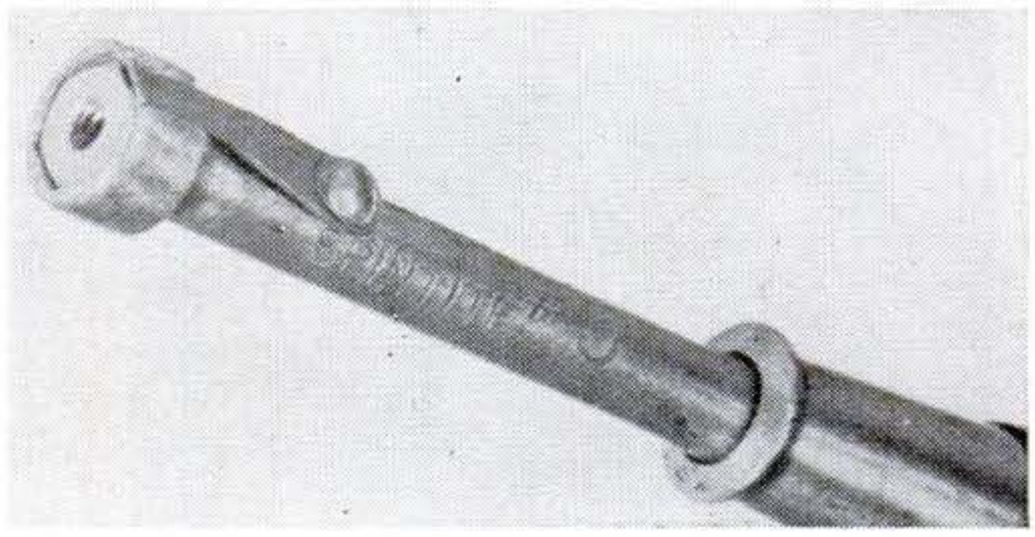
Target Frame Is Portable



HERE is the way I have solved the problem of holding the target when I want to get in a little practice with my rifle. The supporting frame is easily carried and can be set up anywhere it is safe to shoot.

It was made from 1/16" wire and four spring clothespins, the wire being thrust through the springs of the pins. If angle corners are bent as shown, the pins will not slip.—BERNARD V. MIDDLETON.

Clip Holds Nut on Wrench



REMOVING or installing a nut in a tight place may be simplified by adding a small flat spring to a socket wrench. It's secured by a small bolt threaded into the shank.

While a nut is being installed, the clip will keep it square with the bolt or screw until firmly started, but the wrench can be easily pulled away after the nut has been turned up tight. Likewise, the clip retains a nut after it is removed.—C. SAENGER.

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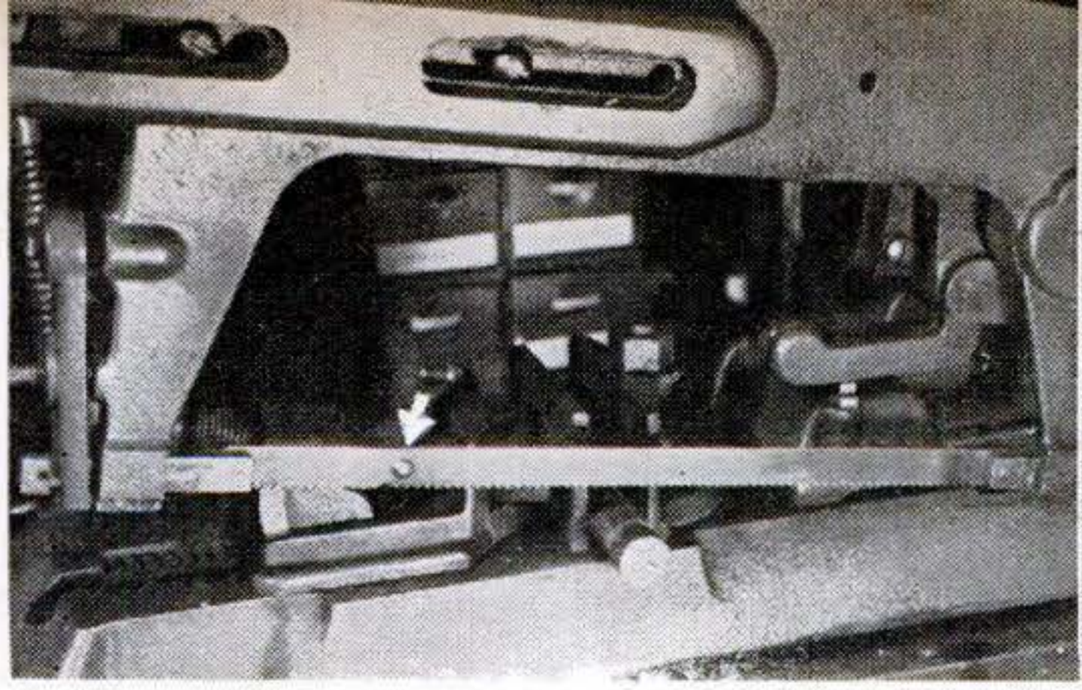
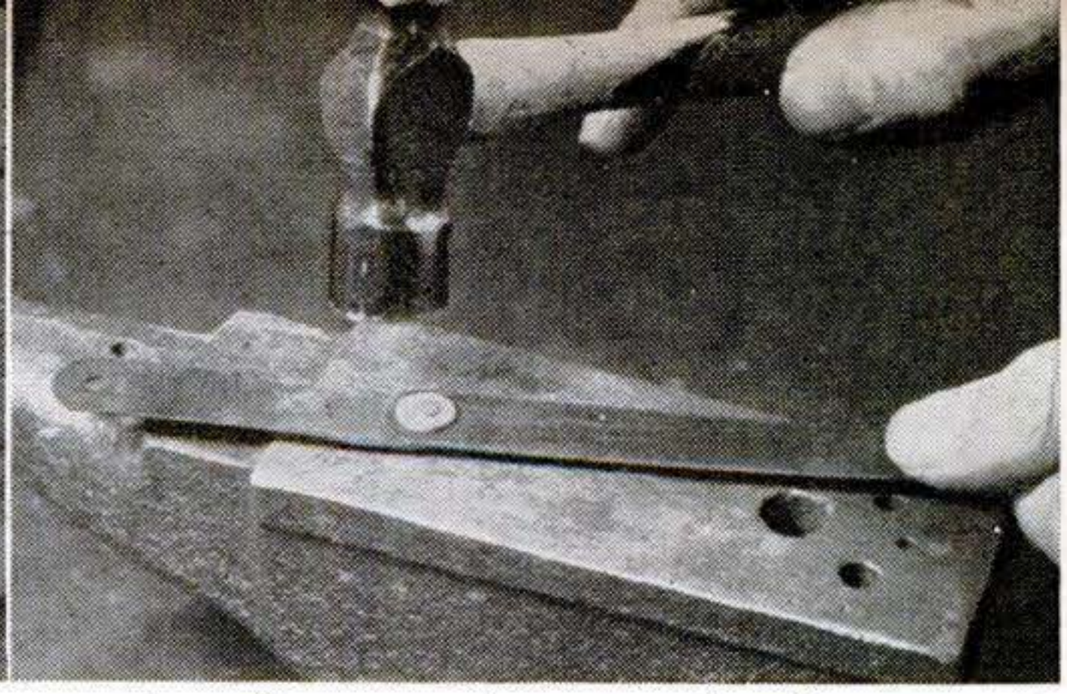




Cutting a blade that has broken or worn only at one end and transposing its parts will double its life. Heat the worn area to soften the metal for cutting, drill holes in the cut ends, and rivet together what were the original ends as at right above. Such a blade will cut diameters up to the limit imposed by the splice. The arrow (left) shows a spliced blade at work.

Hacksaw Hints Speed Power Sawing

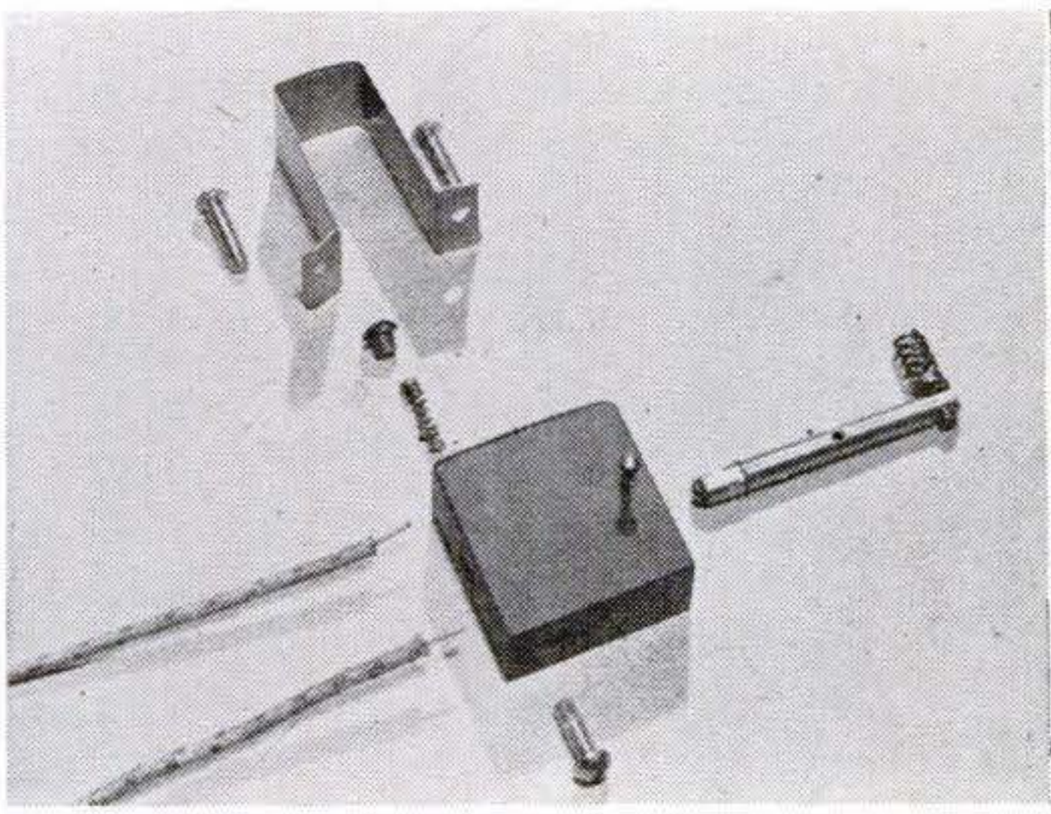
HERE are three suggestions for improving the operation of a power hacksaw—a method of repairing a worn or broken blade, a switch that automatically stops the saw on completion of a cut, and a rubber bumper to cushion the dropping saw arm.

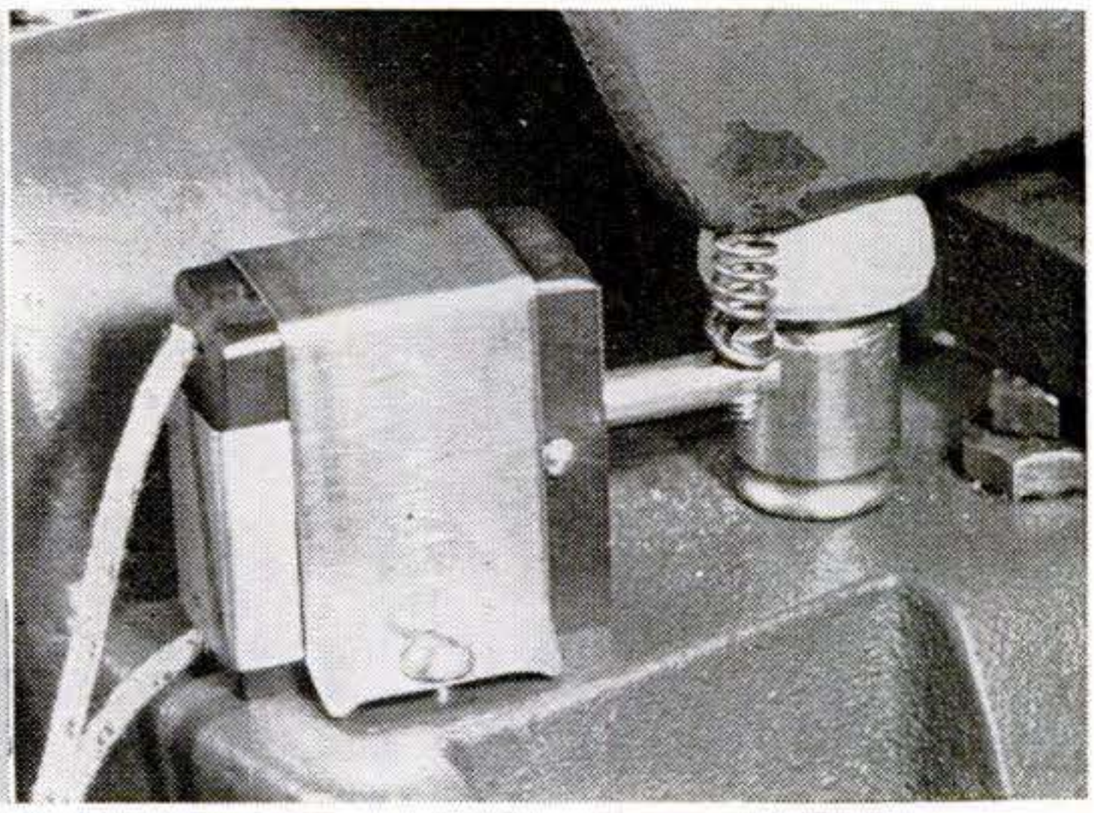
Sometimes a blade wears most near one end because only small-diameter work is cut, or the teeth may break at that end. If the saw can be reversed so it cuts on the push stroke instead of the pull, or vice versa, these half-used blades can be turned end-for-end. Otherwise, the blade may be cut and the sections reversed as shown above. Bend the worn section to a slight offset so the good one will run straight and true.

If a microswitch is available, you might adapt it for use in stopping the saw. In the homemade switch below, the lever that breaks the circuit is a 3/16″ rod pivoted inside a 5/16″ hole drilled horizontally through a fiber block. The inner end of the lever, turned down to a diameter of 1/8″, is fitted with a brass collar, the latter being insulated by a mica strip and washer.

A 6-32 brass bolt in the lower half of a hole drilled vertically through the block serves as one terminal. The other is an 8-32 brass bolt 1/8″ long pressing against a coil spring in the upper part of the hole, the spring contacting the brass collar and keeping it in turn in contact with the lower bolt. Small holes drilled in from the sides admit the wires to the recessed heads of the bolt. A metal band holds the switch on the saw base and a C-shaped guard under it keeps dirt out of the 5/16″ hole.

The bumper consists of a mushroom-shaped rubber button (a crutch tip might be used) pressed into a collar. This collar, which has a 1/8″ pipe thread, was screwed on a nipple screwed to the saw base with an 8-32 flathead bolt.





When a cut is finished, this switch stops the saw motor automatically. Simultaneously, the rubber bumper shown at the right cushions the falling saw arm. A pivoted switch lever, seen at the extreme right in the photo at the left, breaks the circuit when the saw arm depresses the spring on its outer end. An inner spring closes the circuit while the saw is operating.

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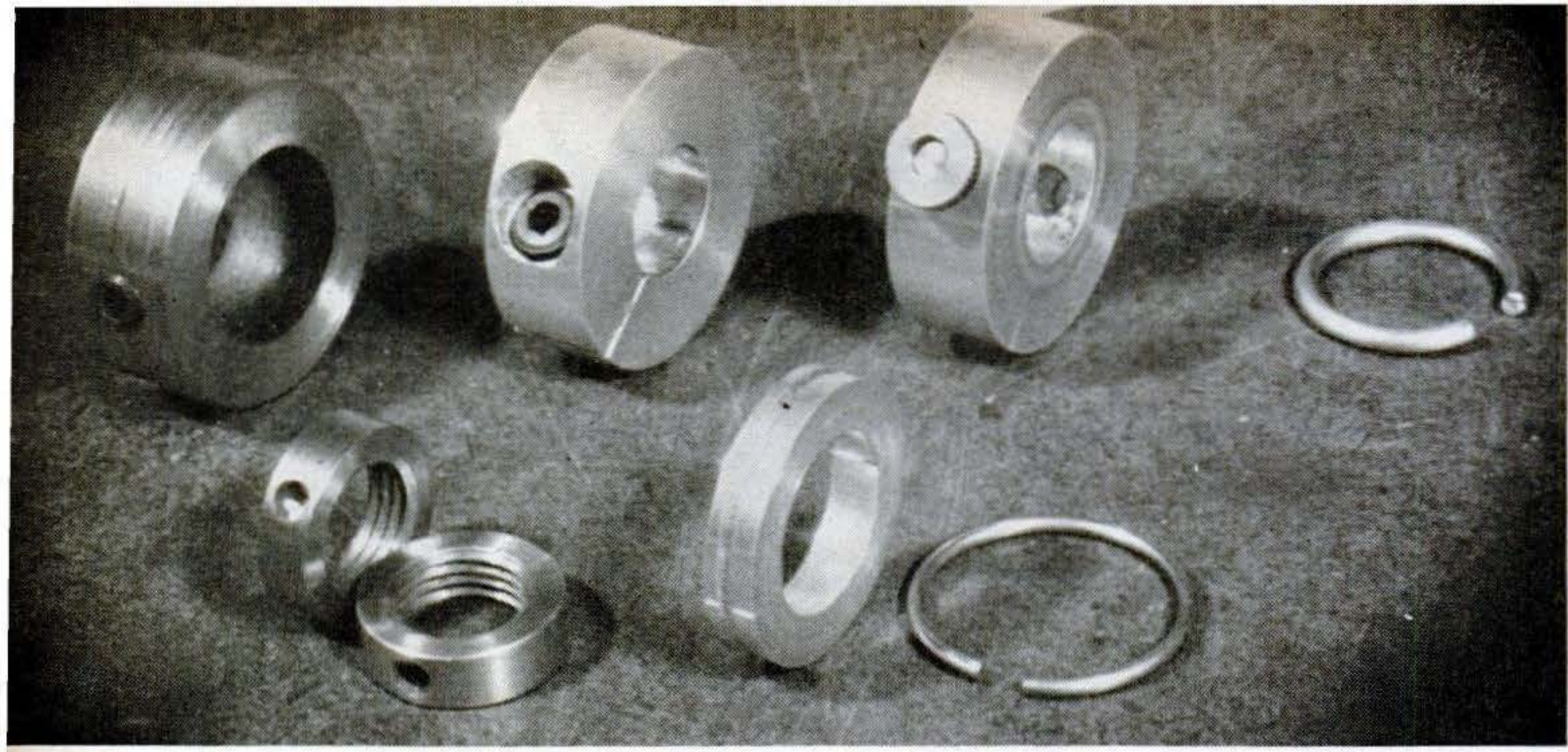


Collars to suit many demands can be turned out readily in your own shop. Top row, left to right are setscrew, clamping, spring-pin, and simple snap-ring collars. Pictured in the lower row are two spanner-tightened threaded collars and a split collar fitting a groove in the shaft. This one is held together by a ring that is snapped around the two-part collar.

Shaft Collars to Fit the Job

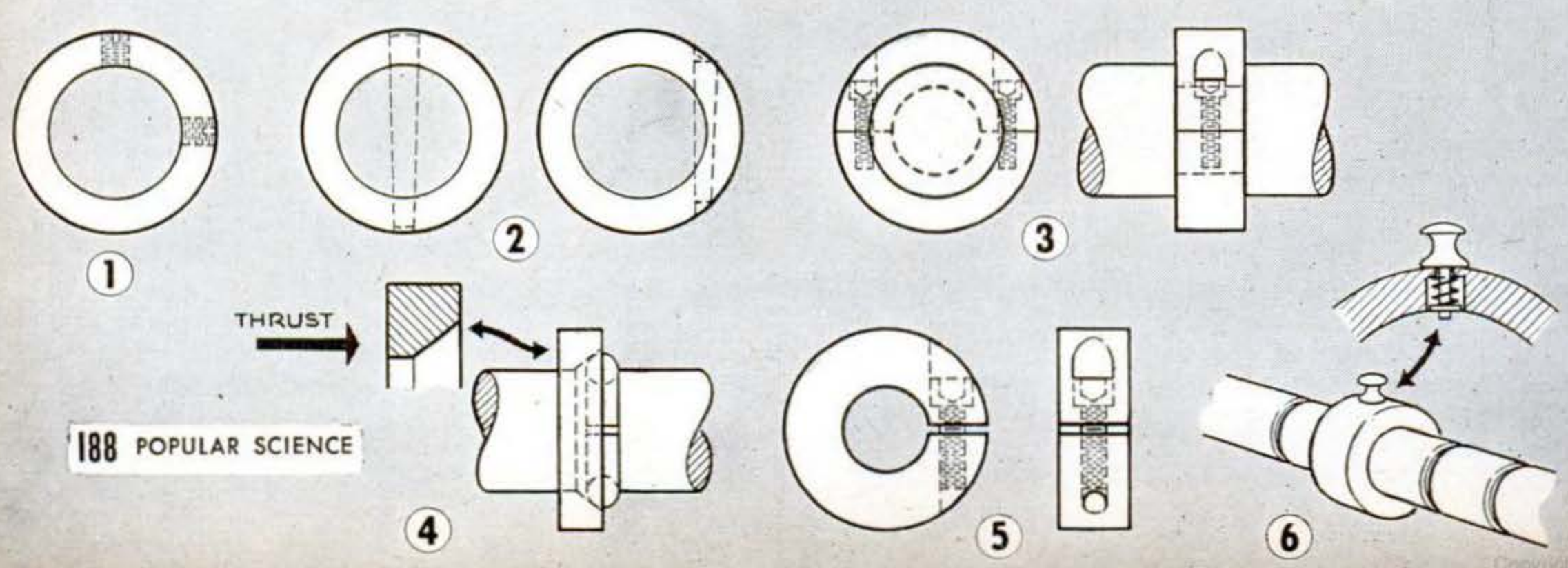
By W. A. Conway

MOST mechanics have at one time or another to make and fit a shaft collar, either in the course of building new equipment, or in repairing a defective mechanism. Before you decide on the kind of collar to be made, note first the nature of the loads that will be placed on it, and whether or not subsequent disassembly will be necessary. If it won't be, the collar may be pressed, shrunk, or silver-soldered to its shaft.

Perhaps the simplest removable collar is one retained by setscrews, as in Fig. 1. This is best suited for light duty, since it has relatively little thrust strength, as well as a tendency to loosen under vibration. Unless dimples are provided on the shaft (thus rendering location adjustment impossible), the setscrews may cause shaft burrs that can make removal difficult.

A stronger collar is shown in two forms in Fig. 2. It uses either a straight press-fitted pin, or if removal must be facilitated, a standard taper pin. If a central hole would weaken the shaft too much, the pin can be placed at the side with about half its diameter in the shaft.

Where thrust loads are heavy, a split collar fitted to a groove turned in the shaft (Fig. 3) is often satisfactory. In small work the screws holding the split collar together may be replaced by a snap ring, as shown in two photos. If space is lacking, a snap ring alone fitting a shaft groove is often employed. The tendency of the ring to jump its groove under heavy thrust can be eliminated (provided the thrust is from only one direction) by using an additional collar chamfered to bear in on the ring (Fig. 4).



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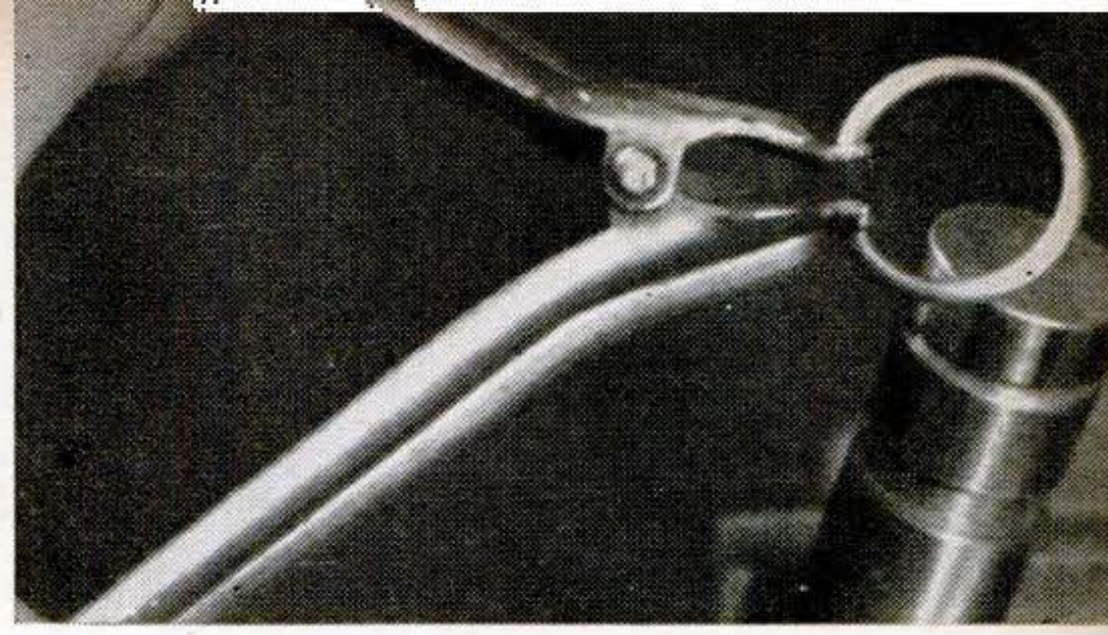
Fitting a split collar, using a ring retainer. A ring collar is also in use on the shaft end.



Expander pliers are used to install this ring in the round-bottom groove turned to receive it.

The clamping collar in Fig. 5, for use on tubing or on shafts that must not be marred, has only moderate thrust strength but can be located at will. For fine location adjustment, threaded collars are ideal. Though troublesome to make, they are especially good in applications where delicacy of adjustment is vital, such as on machine spindles running on antifriction bearings, where it's desirable to just remove end play.

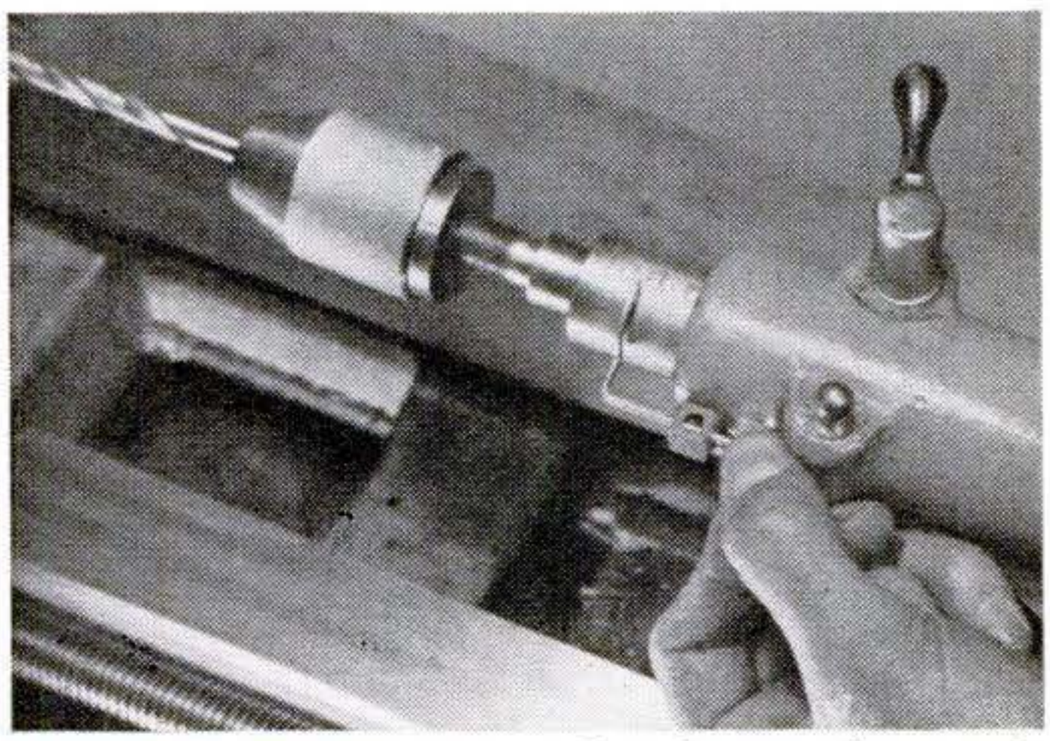
For speedy change among predetermined positions, the collar shown in Fig. 6 is valuable. The locating pin seats in grooves in the shaft, or in the case of tubing, in holes.

Delicate adjustment of end play is possible with a pair of threaded collars. After one is turned to the right place, the other locks it.

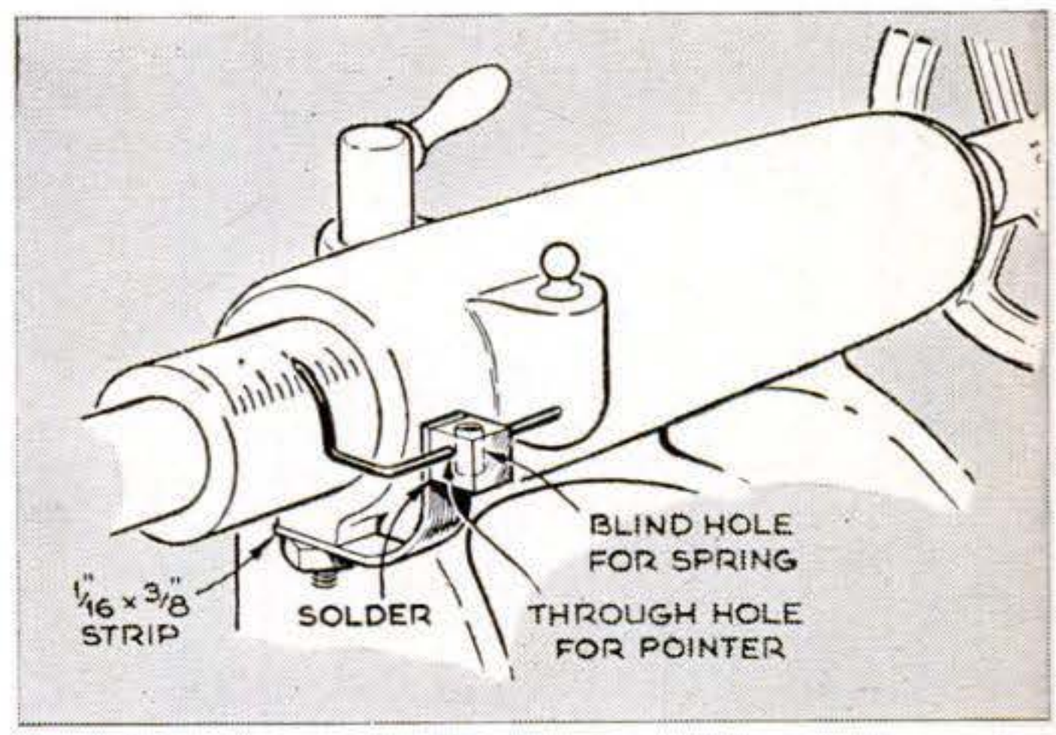
Pointer Helps Gauge Depth of Drilling in Lathe

ACCURATE drill-depth measurements in the lathe are easier if you use this adjustable depth indicator. When the drill touches the work, the pointer is set to the nearest inch mark, eliminating the need for noting and remembering the odd fraction at which drilling might otherwise begin The actual hole depth is then always indicated.

The pointer, bent up from a length of bicycle spoke, slides in a hole drilled through a small brass block and is held in position by a small compression spring in a blind hole. A brass strip soldered to the block runs underneath the tailstock to the keyway-locating screw, on which it is held by the locknut on this screw. The spring is compressed in the block and the pointer passed in over it so that spring pressure will hold the pointer in place. This method, which retains the pointer position reliably and yet allows it to be moved easily, dispenses with the need for a setscrew.—RICHARD HANSCOM.



Errors in drilling are far fewer if you fit your lathe with this gauge that indicates how much you have advanced the tailstock barrel.



No holes are made in the tailstock in order to mount the gauge. Instead, it's simply clamped under a nut on the keyway-locating screw.

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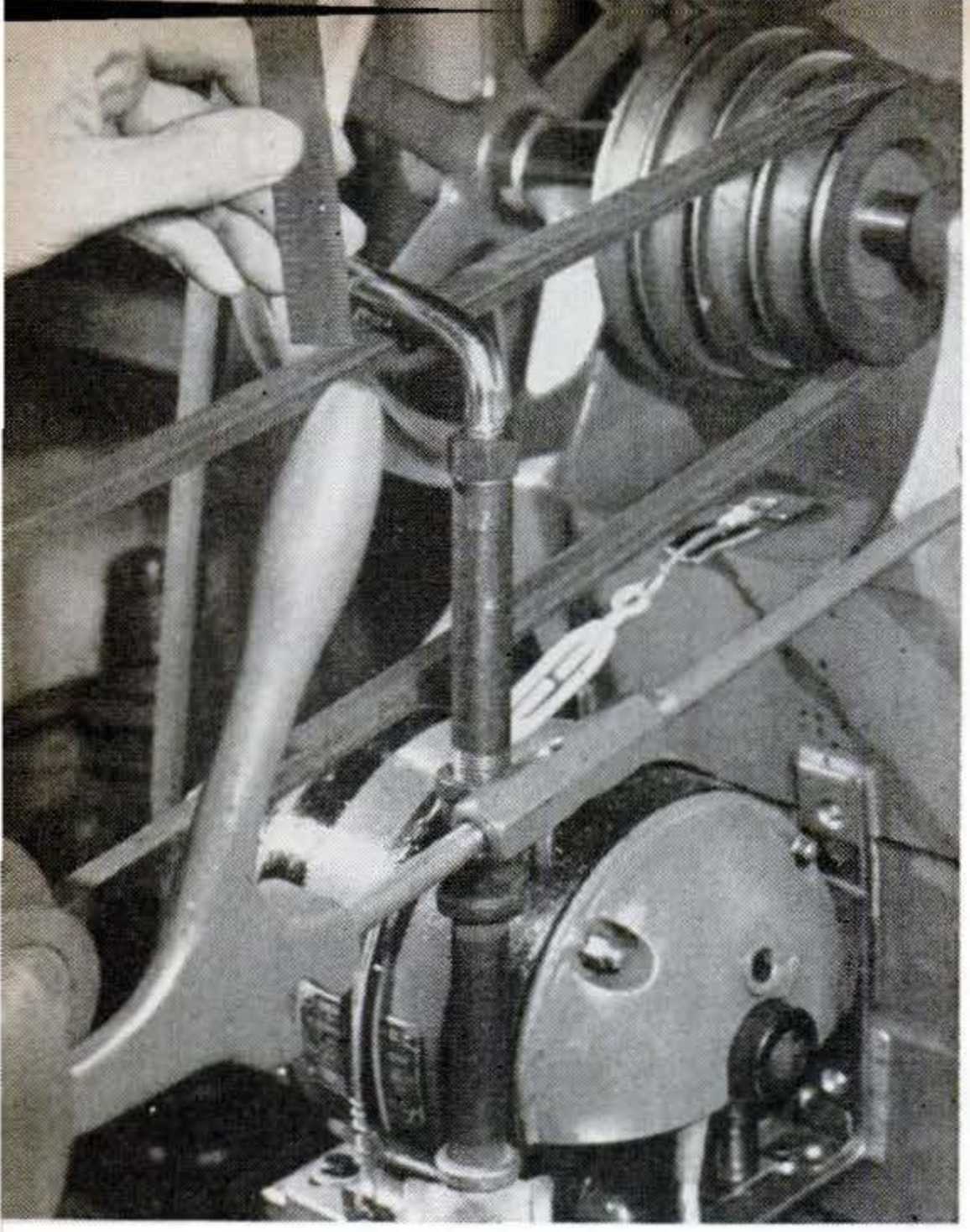
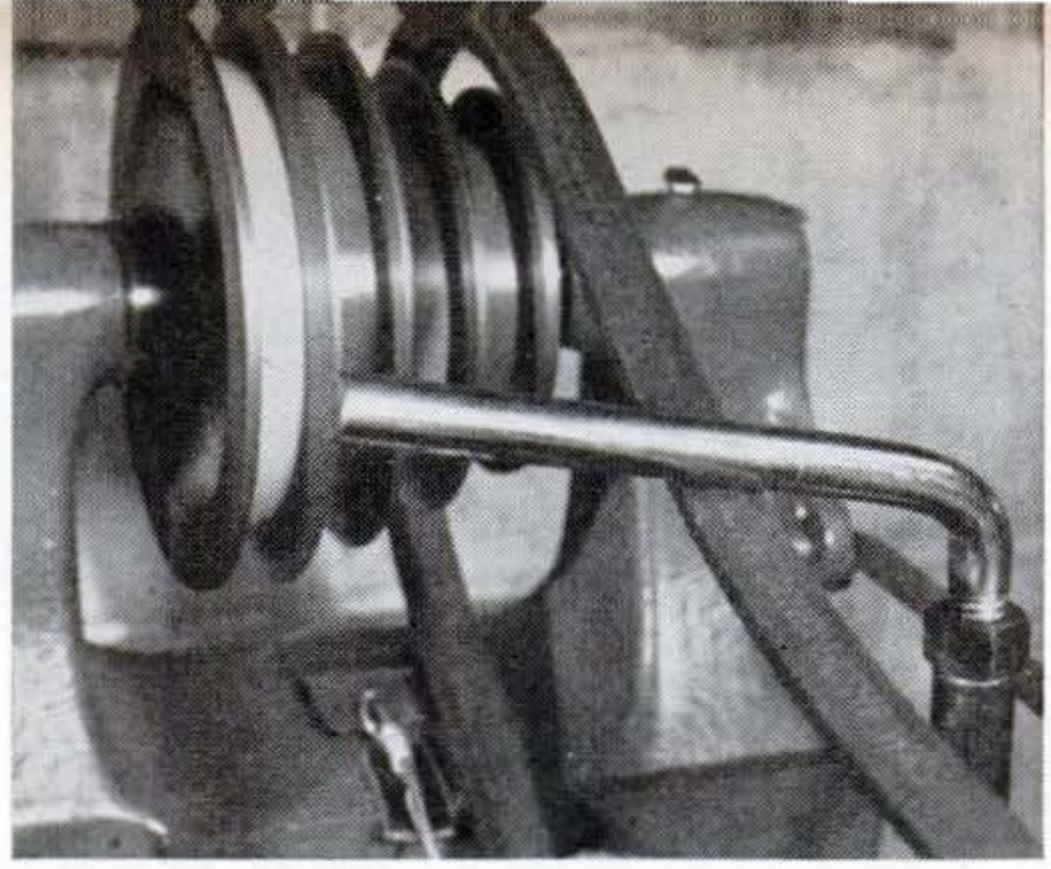


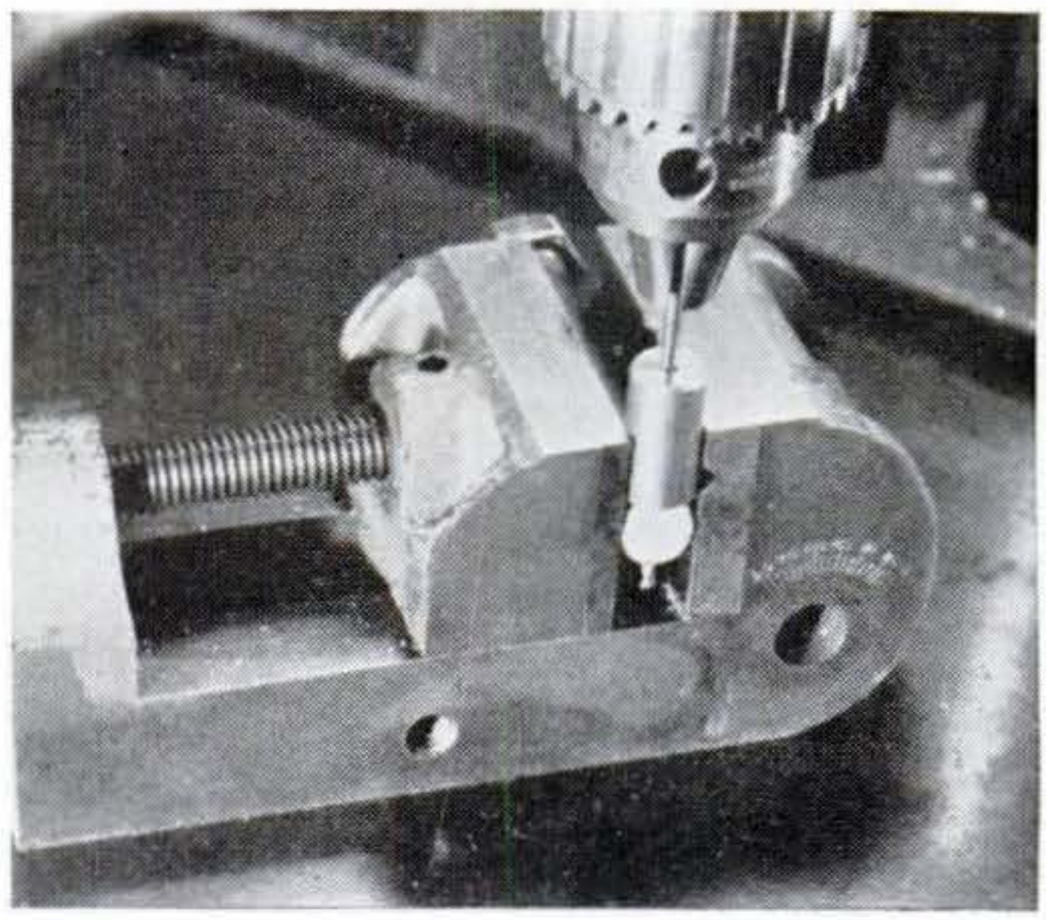


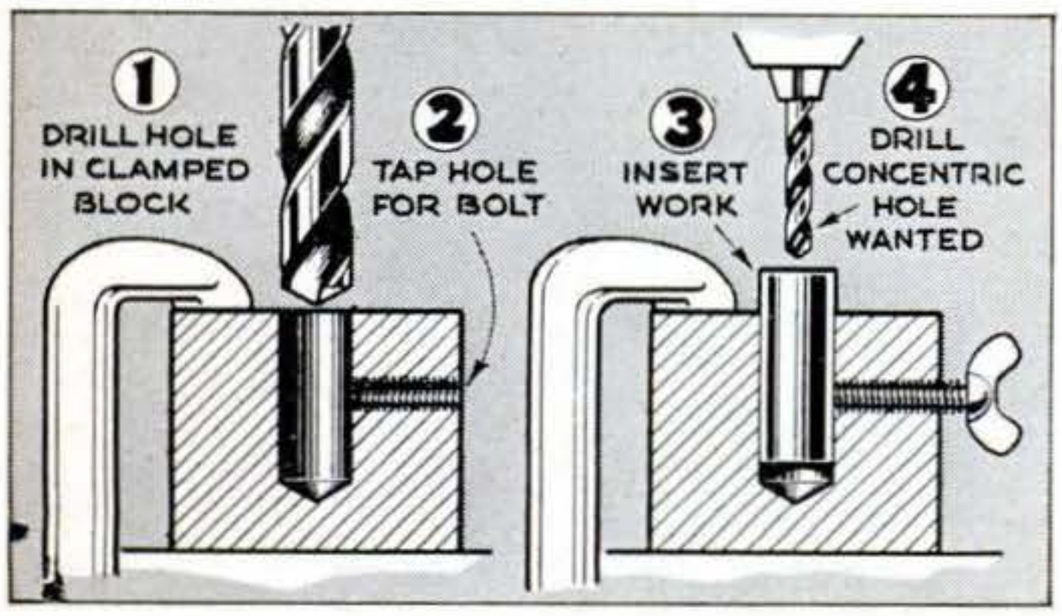
Stopping Spindle Drag. One drawback of a lathe having a V-belt drive between jackshaft and spindle is that, even with a slack belt, drag will often keep the spindle turning at considerable speed. This is because a V-belt tends to assume a circular shape when not under tension, and thus remains in contact with part of each pulley.

To overcome this tendency, mount a smooth bar or tube so that it is about ½" above the top of the belt when the latter is under running tension, as at left above. The bar can be held by a length of pipe or bar stock attached to the bench top with a floor flange. Bend the bar, if necessary, so that it is the same distance above the belt in all pulley steps. When the jackshaft is released (right above), the bar keeps the belt in the shape of a flattened oval. This keeps it long enough so that it does not tend to hug either pulley groove, so effectively reducing slack-belt drag.—WALTER E. BURTON.

NEW SHOP IDEAS

Tip for Lengthwise Drilling. When round work is to be drilled lengthwise on a drill press, the hole may be centered as shown below. In a block of oak or maple clamped to the table, drill a hole (1) to take the work and a horizontal hole (2) for a setscrew. Insert the work (3) and turn up the screw. When the drill is lowered (4), it will be exactly centered.—L. S. ISOLA.





Kink for Cross Drilling. Round work can be cross-drilled accurately on a diameter with a jig like that above. It is a piece of round stock the diameter of the work, with a hole of the desired size drilled lengthwise through its center in the lathe or by the method shown at left. When the work is clamped in the vise at right angles to the jig, the latter will guide the drill exactly through the center.—C. W. WOODSON.

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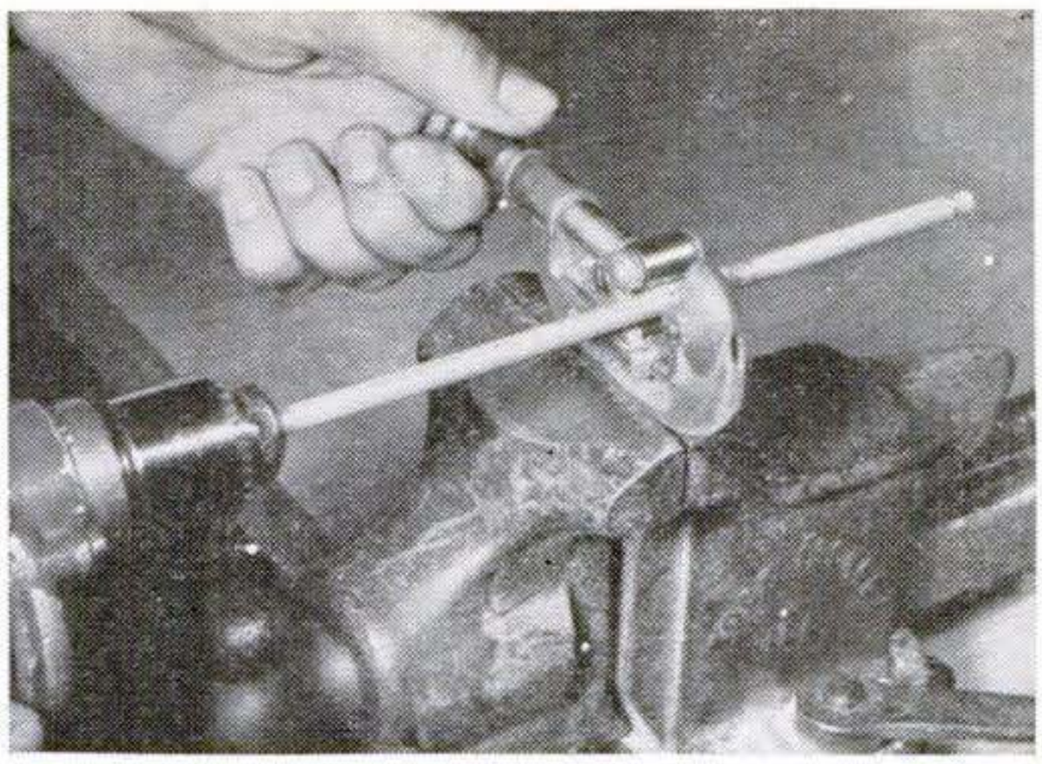
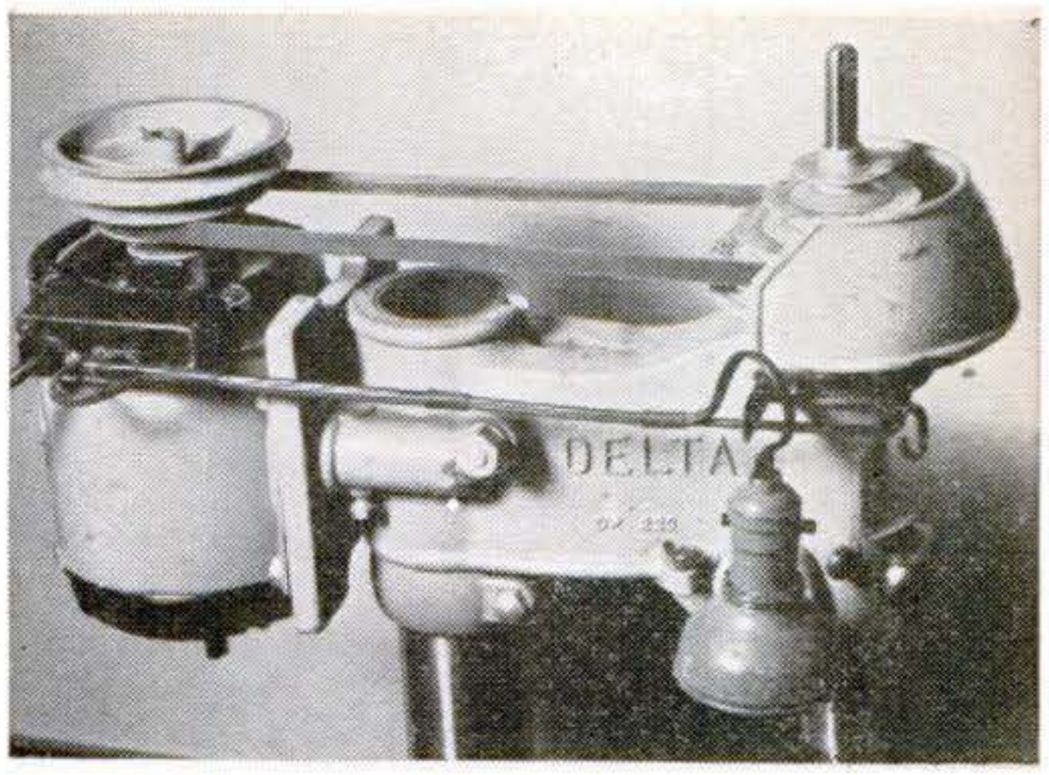
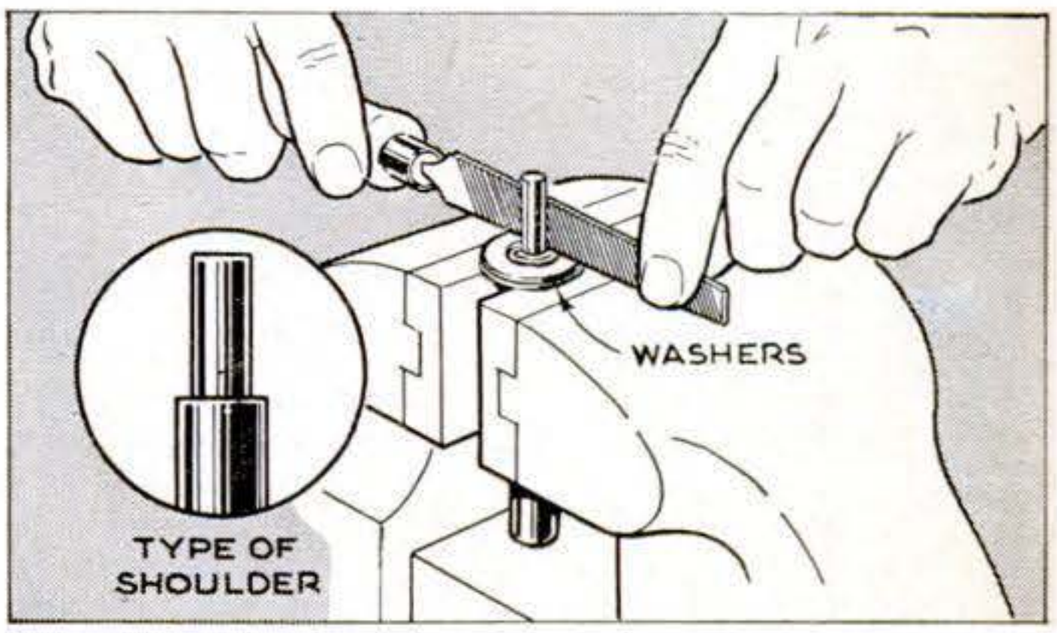


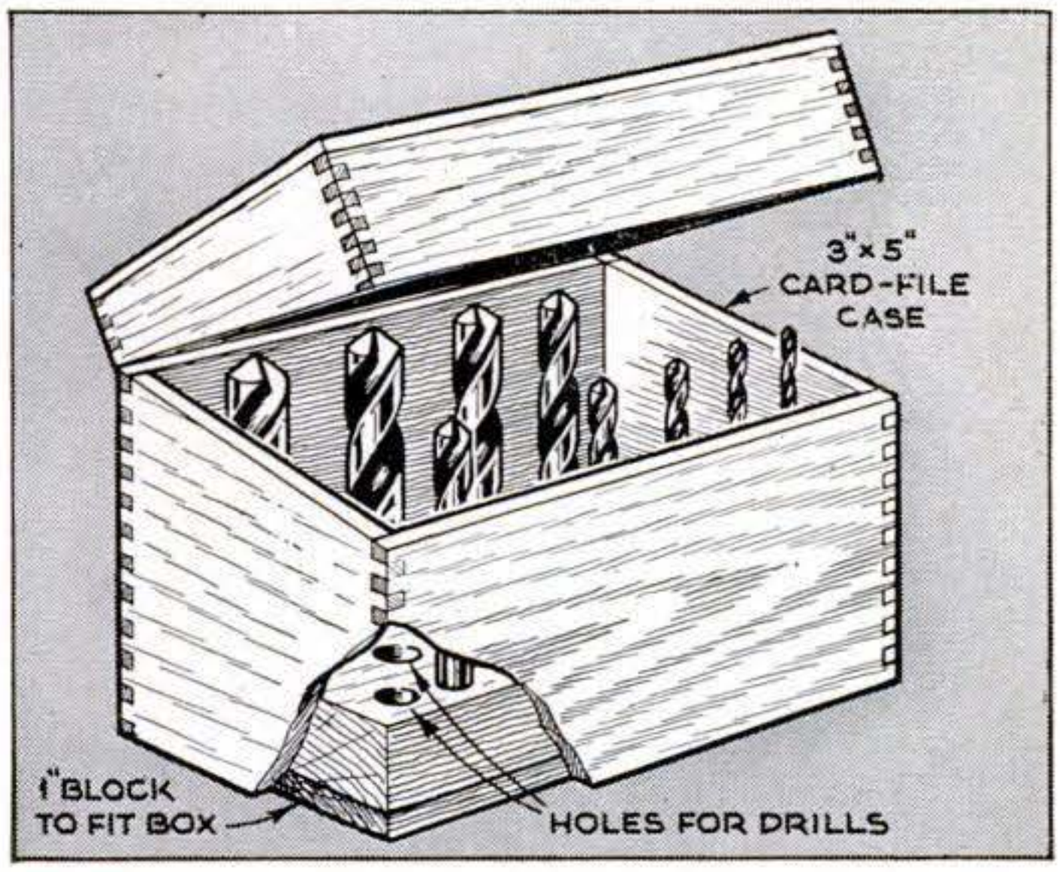
Drill Helps Cut Tubing. Cutting tubing to length can become quite a tiresome job if many pieces are needed. However, the job may be eased considerably by letting an electric drill do most of the work. Steady turning of the tightening knob will produce a fast cut. A drill press also might be used, with the cutter held in the hand. In that case, be sure you use a slow speed and tighten the cutting knob gradually.



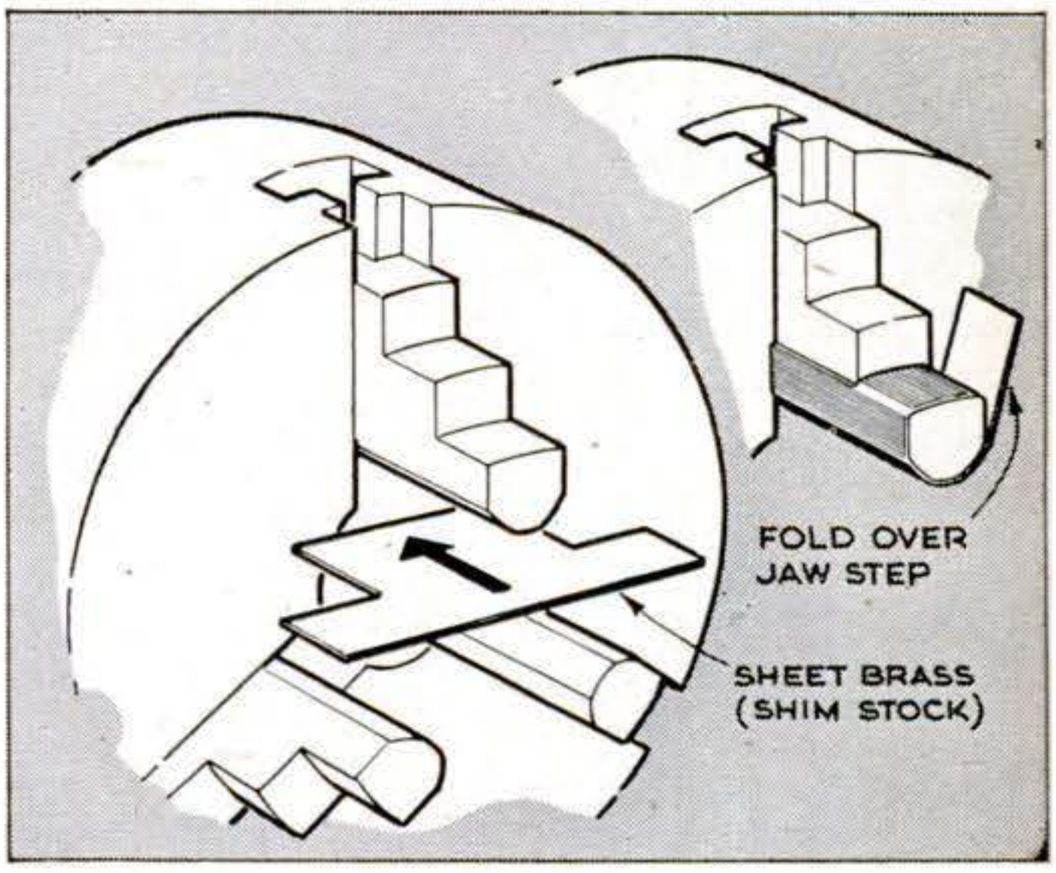
Drill-Press Wiring Reduced. Two electric cords usually run to a drill press of the type seen above—one to the motor and another to the light. I eliminated one of them by drilling a hole in the motor switch plate and connecting the light cord to the unbroken lead and the hot side of the switch in the terminal box. The cord was taped to the switch rod in order to keep it out of the way and prevent accidents.

Washers Protect Vise. In the absence of a lathe or other machine tool, a file frequently is used to shoulder the end of a rod. However, this often results in the vise jaws being marred. Two close-fitting washers placed over the work will protect the vise and help do a better job. The washers ride on each other, and the top one serves as a guide that produces a clean-cut shoulder on the work.—CHARLES H. HARDY.





File Box Holds Drills. A file-card box provides good storage for drills and taps, especially extras or those of a different series than your regular set. Cut a piece of wood to fit the box and drill holes in it of the right size.—M. A. JACOBSON.



Clips Protect Lathe Work. Brass clips installed on your lathe-chuck jaws will give protection to work you don't want marred. Made as illustrated above, the clips will suit work of any size and may be used over and over again.—BENJAMIN TASSMER, JR.

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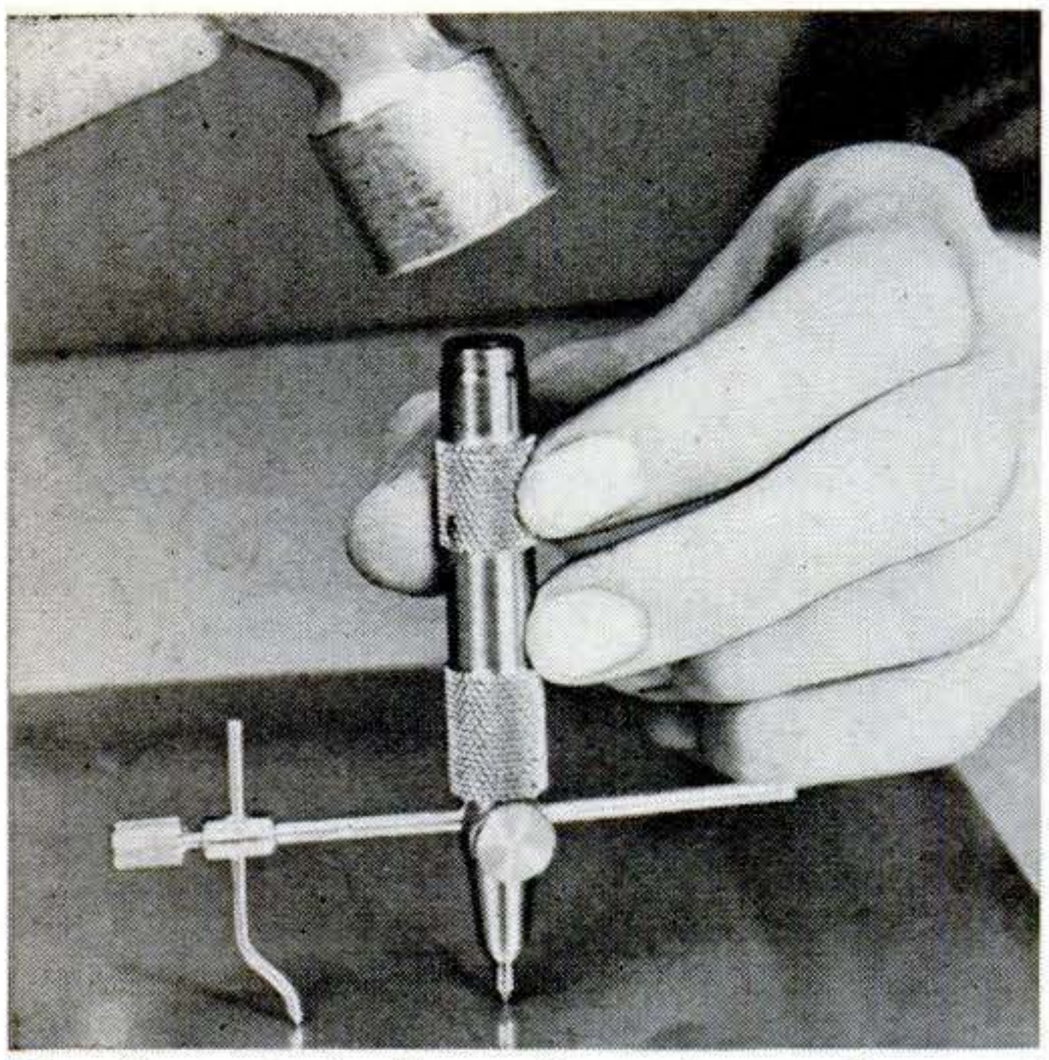
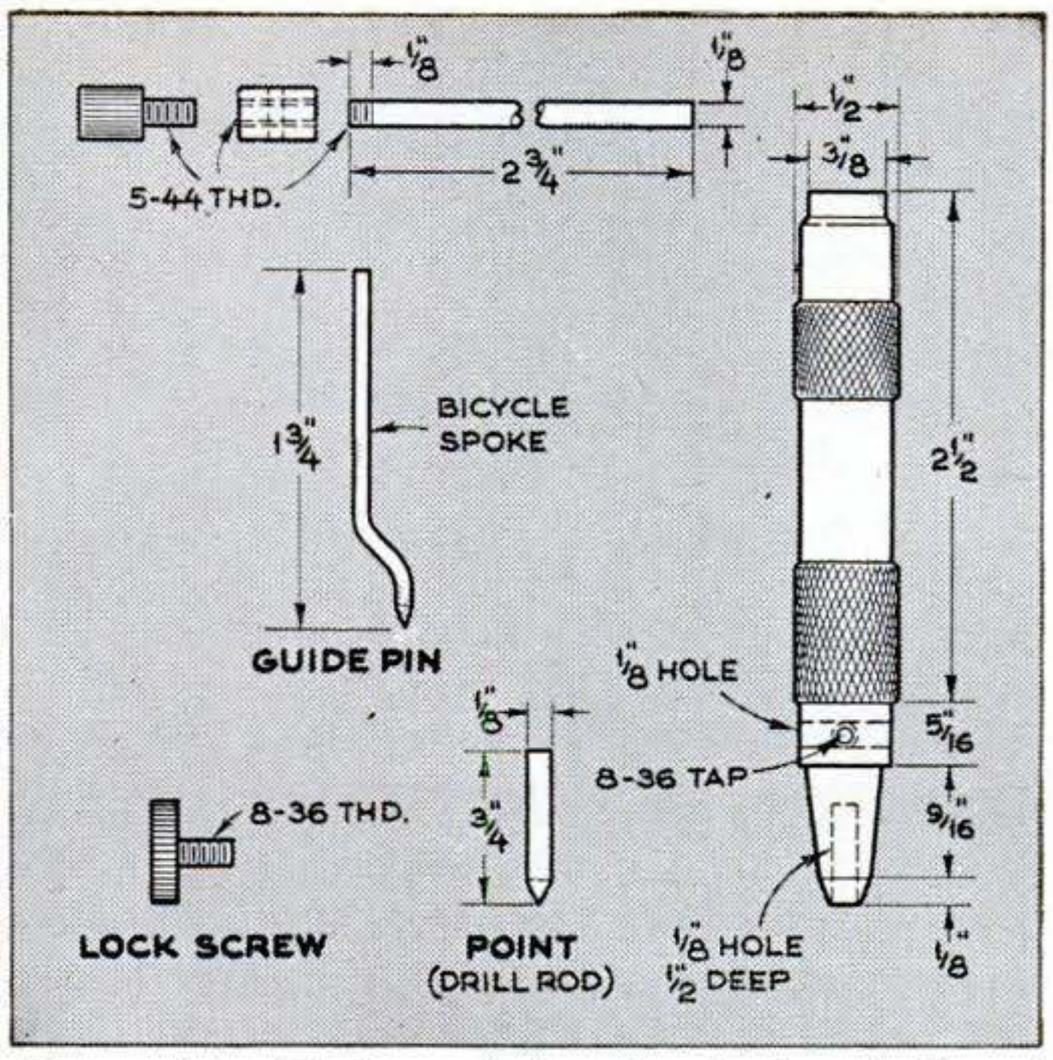


Punch marks in flat work may be evenly spaced by locating the guide in each preceding mark.



Use cold-rolled steel for the body, drill rod for the point and arm, brass for the screws.

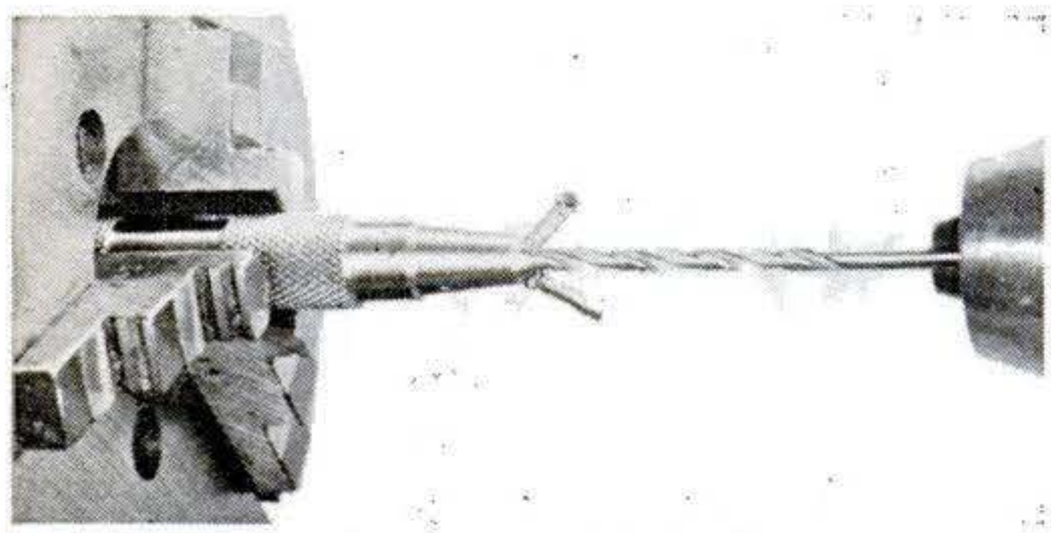
Spacer Punch Locates Layout Marks

EVEN spacing of center-punch holes for contour drilling may be assured by using a punch fitted with an adjustable arm and guide point. After a mark has been punched at the starting point, spacing is automatic by locating the guide in each preceding mark. In addition, the punch may be used like a compass to scribe arcs, and, with the point lowered below the edge of the workpiece, it provides accurate spacing of lines parallel with the edge.

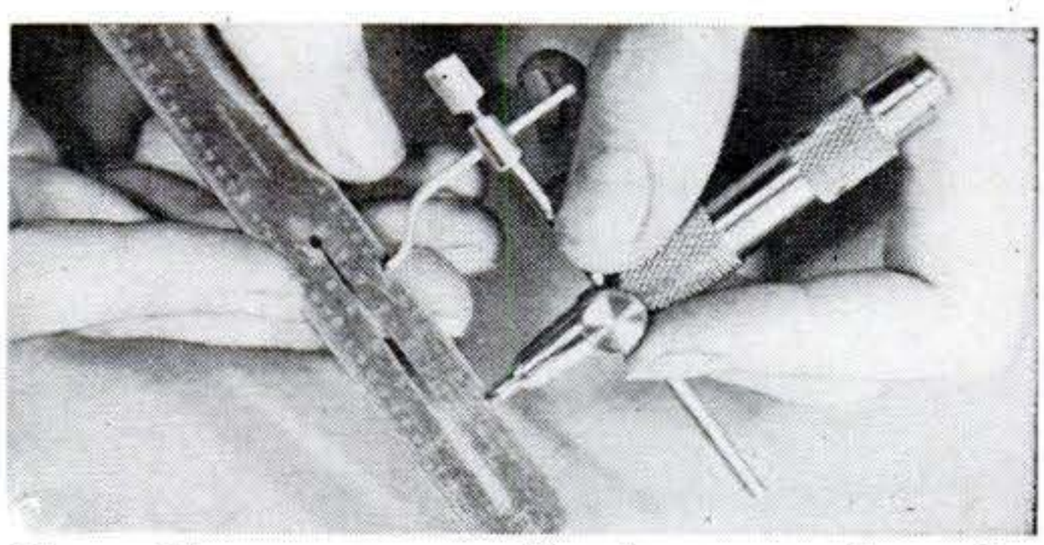
For the body, use ordinary ½″ cold-rolled steel, mounting it between centers to knurl the two indicated areas and to turn down to the specified dimensions. The long taper may be cut on the tailstock end of the work with the compound rest at 6 deg. Cut the small taper with the work in the chuck, after drilling a ⅛″ hole ½″ deep to receive the hardened point. Also drill a ⅛″ hole through the body for the adjustable rod, as well as another at right angles to this for the lock screw, using a No. 29 drill and tapping the hole 8-36.

A feature of the punch is the interchangeable point made from ⅛″ drill rod. After hardening the point by heating to a cherry red and quenching in water, polish it, and then temper by heating to a straw color and allowing to cool in air. To assure a tight fit, it is best to peen it slightly before hardening.

The arm, ⅛″ drill rod threaded for ⅛″ at one end, fits into a ⅜″ section of ¼″ rod drilled lengthwise No. 32 and tapped its entire length. Also drill a hole crosswise in this piece to match the diameter of the guide pin, made from a bicycle spoke. Turn the two lock screws from brass.—RICHARD HANSCOM.



Chuck the punch to drill a ⅛″ hole ½″ deep into the end for the interchangeable hardened point. The latter must be a tight press fit.



Two adjustments, one for the arm and one for the guide point, make it possible to set the punch accurately for extremely fine work.

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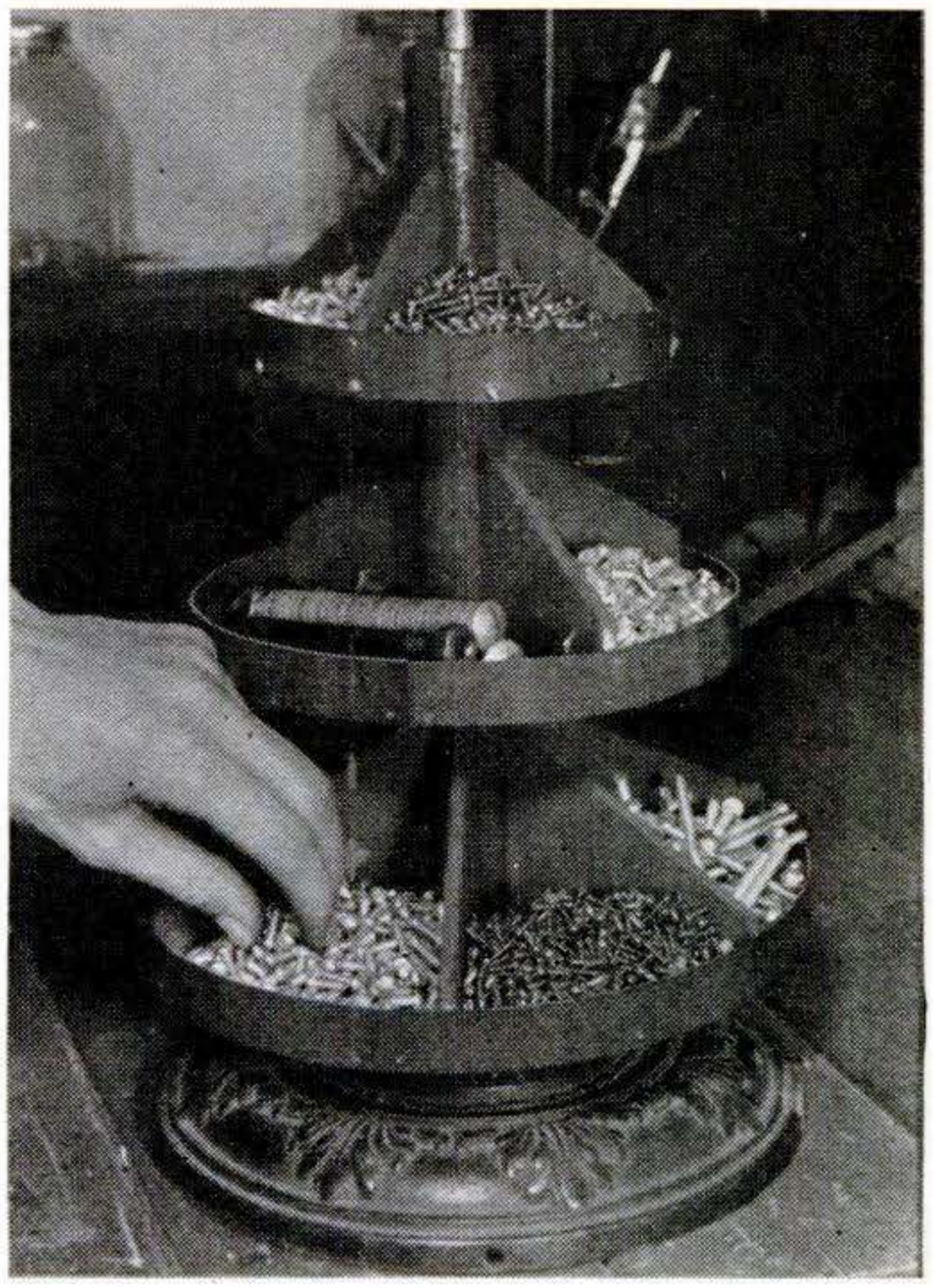
Hardware Revolves in Space-Saving Turntable

A DISCARDED floor lamp provided the base for this turntable rack in which a variety of small shop supplies can be kept separated yet handy. A 15″ length of ½″ steel tube is driven tightly into the base. Three 1¼″ dowels 4″ long are bored through the center to revolve freely on the tube.

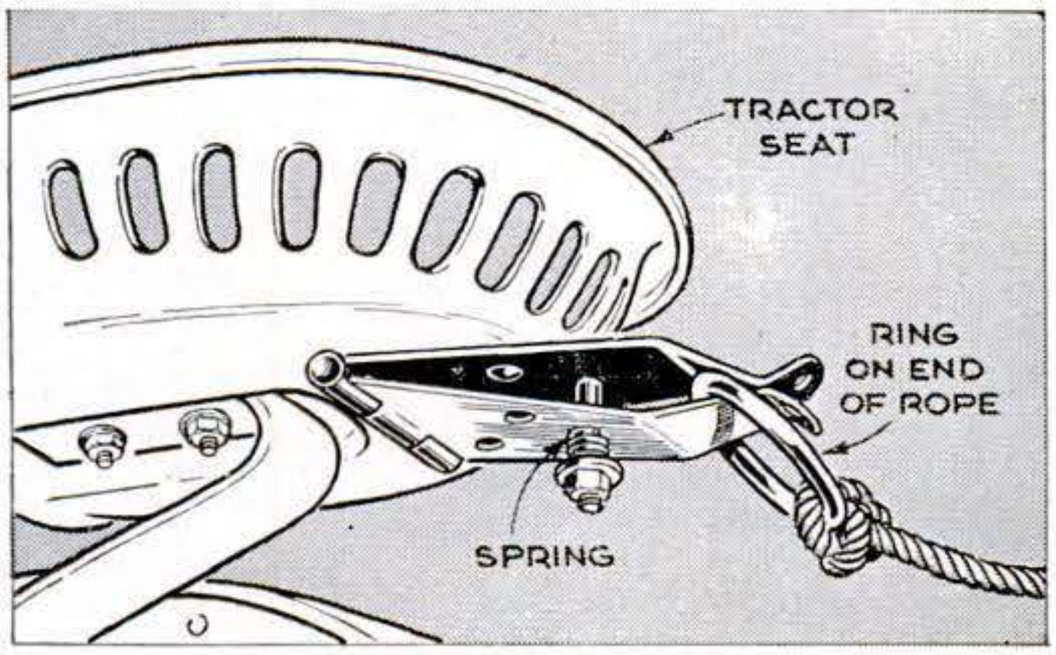
To keep the holes true, drill the dowels on a lathe or, if by hand, from both ends. Plywood disks 6″, 8″, and 10″ in diameter are drilled through the center and screwed to the dowels. The partitions, also made of plywood, are toenailed to the dowels. Nailing the partitions from under the shelves makes a stronger job. A steel washer separates each shelf from the dowels below; when washers, shelves, and dowels are lubricated with graphite, the shelves turn independently and easily.

Cut 1″ strips of thin sheet metal—tin-can stock will do—and attach them to the circumference of the shelves with small screws or nails. A label can then be pasted to the front of each partition to identify its contents.—R. J. DE CRISTOFORO.



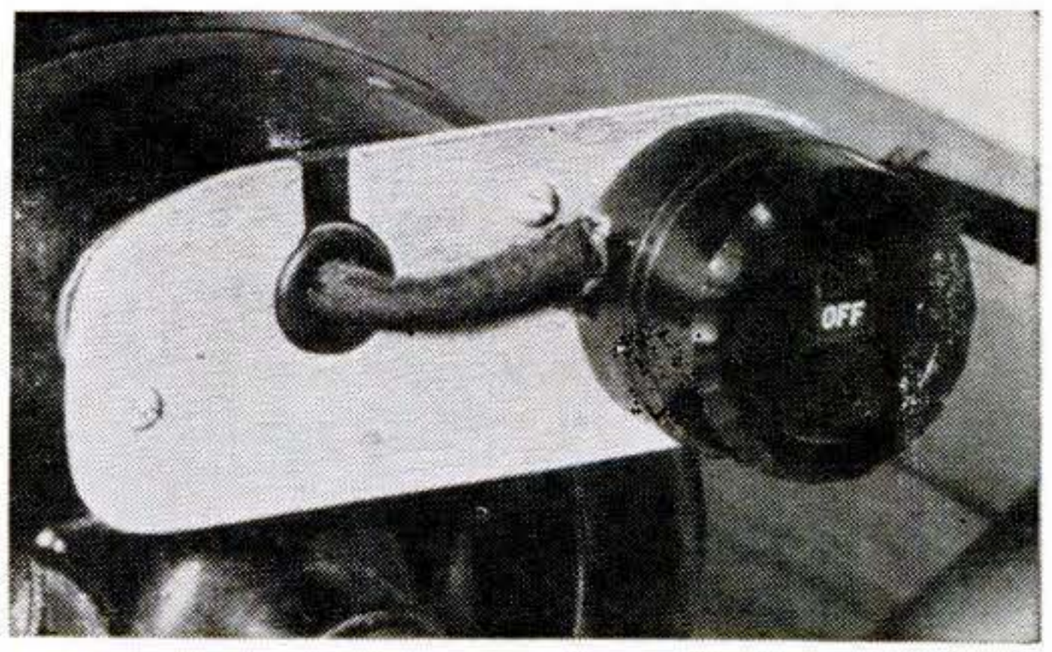
Cloth-Wrapped Tap Enlarges a Threaded Hole

A TAPPED hole sometimes turns out to be too tight for the screw it is supposed to take. If the screw is hardened, or if for any other reason you do not wish to alter its thread, wrap a small piece of cloth around the tap. Run cloth and tap together through the hole. This will cause the tap to cut an oversize thread.—R. J. WRIGHT.



Spring Releases Trip Rope

IT DOESN'T take much of a pull to release a safety trip rope fastened to a tractor by the method illustrated above. A strap hinge bent as shown is bolted to the bottom of the seat, and a nut and washer press up on a spring to hold ring and rope in place. The ring snaps free automatically when the plow is disconnected.—AWALD WEISS.



Switch Modernizes Motor

OLD motors not equipped with built-in switches can be used conveniently if a standard surface-mounting toggle switch is mounted on a piece of plywood and attached to one end of the motor as indicated in the photo. The screws holding the cover plate on the terminal box will secure the plywood.—GLENN A. WAGNER.

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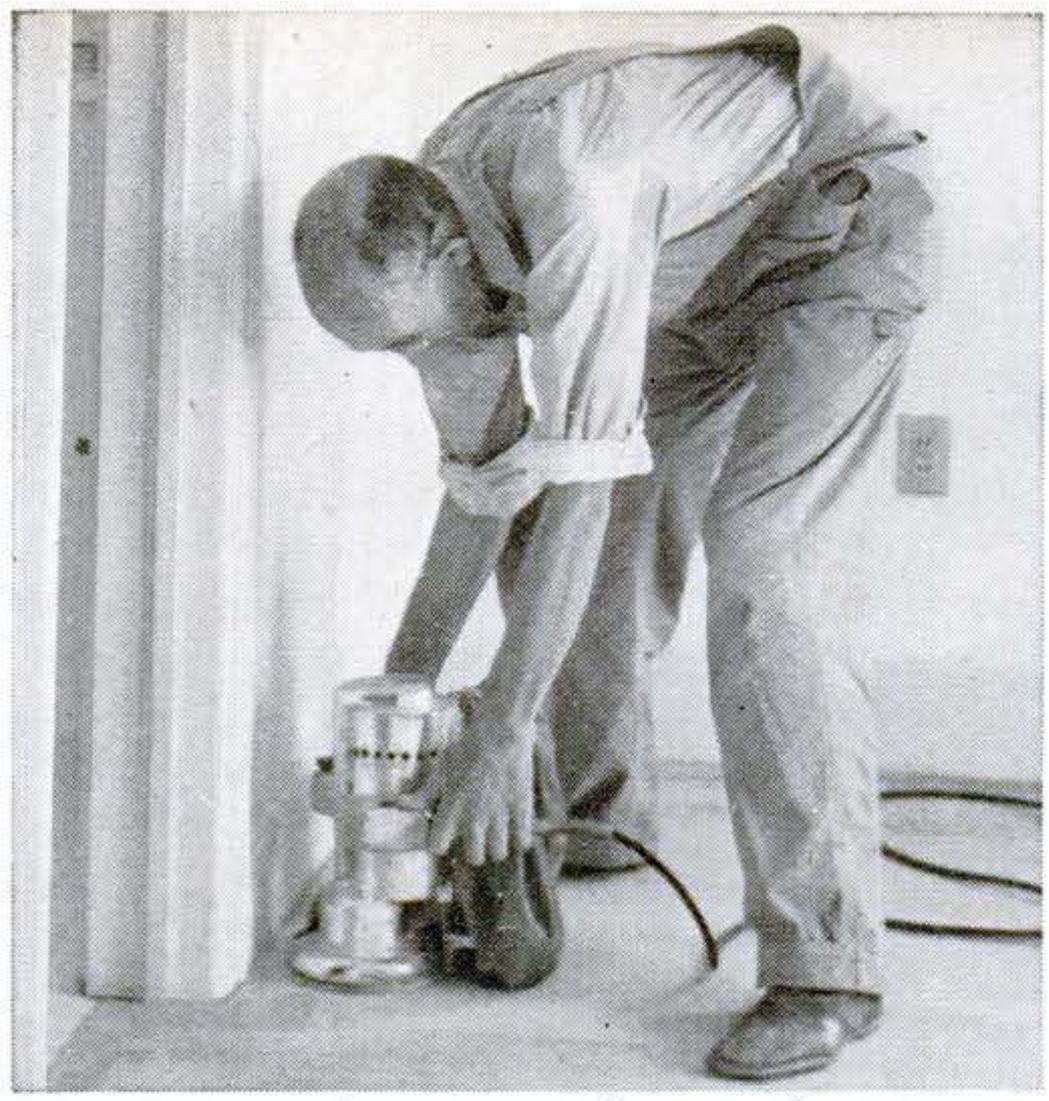
Drum-type machine is best for sanding the field area of a floor. Sand this area first.



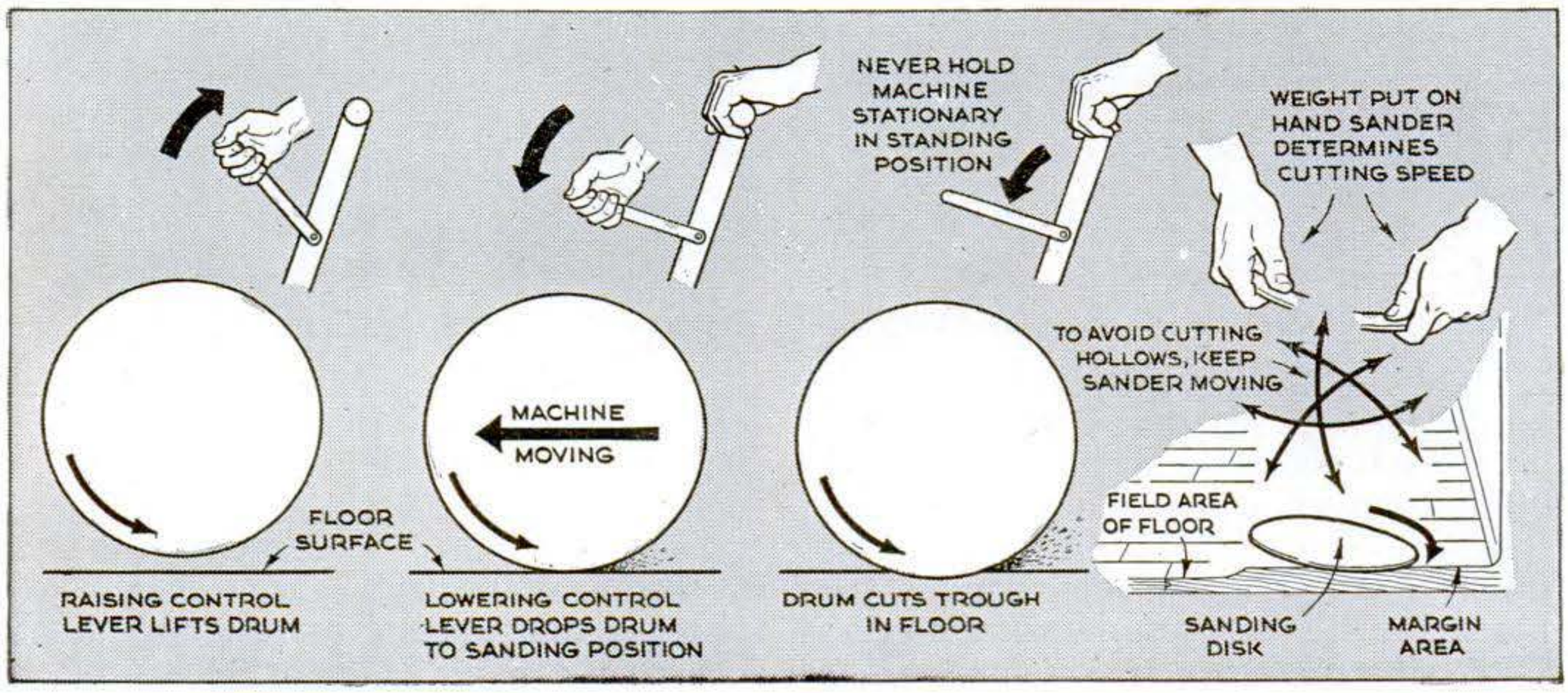
Disk-type sander gets in closer at the margins; use it near baseboards to do a good job.

Power Sanding Renews Old Floors

FLOOR sanding machines may be rented by the day in many communities, and sandpaper of various grits is usually provided at a charge based on the number of sheets required. By reducing the rental time to a minimum and avoiding waste of paper, the cost of a floor-finishing job can be held to a very moderate level. The profitable use of rented sanders, however, calls for a certain amount of advance planning as well as some knowledge of the machines themselves.

Before the sanders are brought to the job, everything should be made ready for them. Construction and repairs on walls, ceilings, baseboards, and woodwork should be completed and the refuse swept up; if possible, close off the area to traffic. Inquire about the current consumption of the machines that are available; you may need a larger fuse for the electrical circuit into which the machine will be plugged.

Sand the field area of the room first. A large, drum-type sander is best for this work. The paper to be used on the drum depends upon the condition of the floor. Use coarse paper for roughing off paint and dirt coatings and for taking down the high spots. Holes resulting from broken-off splinters and other defects may be filled with composition



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wood after the rough sanding. Medium paper should be used for average uniform flooring. Finish the job with a fine grade of paper.

When operating the drum-type sander, make sure that the control lever is in the up or idling position before you switch on the motor. Lower the control slowly so that the moving drum makes gradual contact with the floor, and keep a firm grip on the handle to prevent the paper from grabbing and jerking the machine out of control.

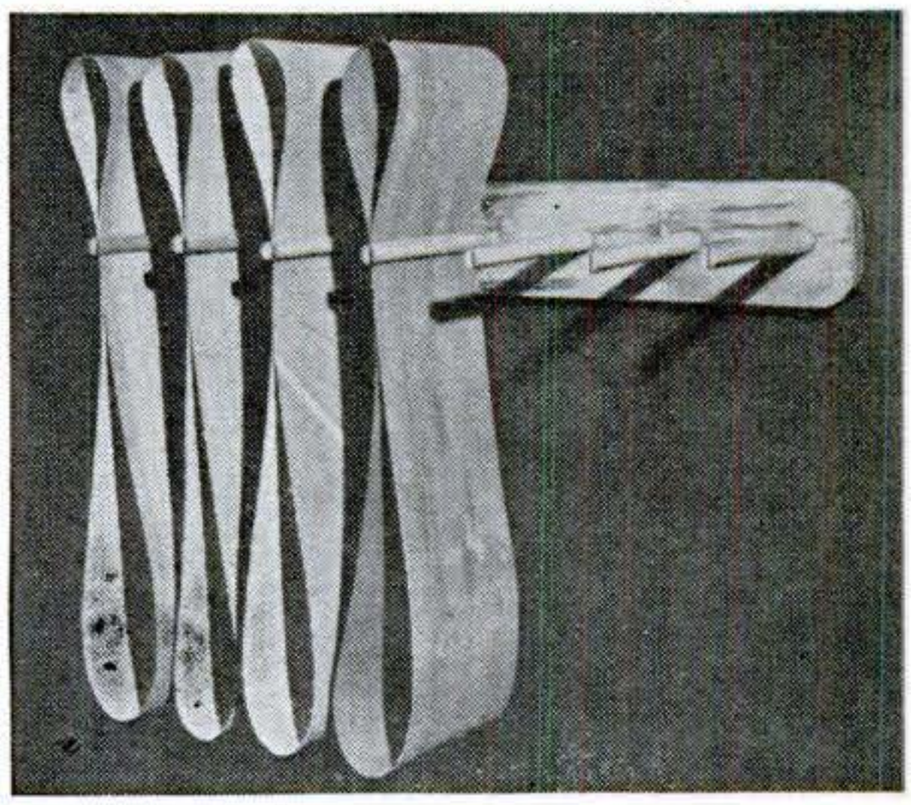
Never hold the machine or permit it to stand in one spot while it is sanding, as this will quickly produce a trough in the wood. To remove trough marks it is necessary to smooth down a considerable area, and this is wasteful of both time and paper.

Best results are obtained by making slow runs forward and then reverse in the direction of the grain. Repeat as many times as necessary, and change the paper whenever the old sheet becomes worn or clogged. A worn sheet won't do the job.

For the margins, a small disk-type sander, also shown on the opposite page, is more convenient. Unlike a drum sander, the disk-type machine depends upon the weight of your body for its cutting action. This permits regulations of depth and speed of operation, and by applying the right amount of weight you can make the margins blend into the field area without any noticeable dividing line. Empty dust bags before they become full, as overloaded bags impair the operating efficiency of the machines.

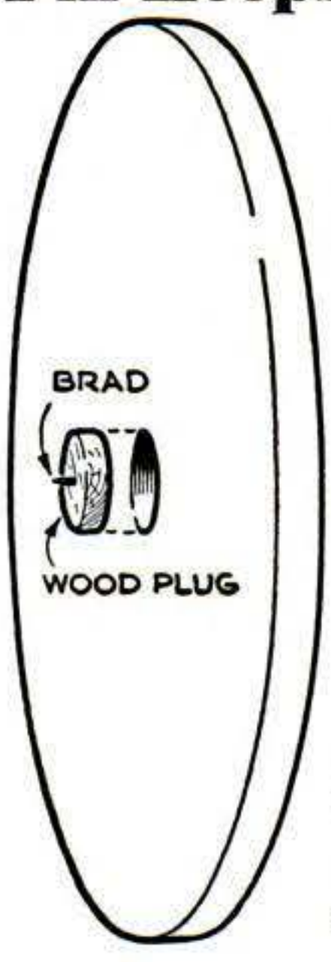
Whenever possible, plan in advance on the kind of finish you want to apply to the floor, and have the materials handy so that you take advantage of the clean and freshly sanded surface. If you cannot finish the floor immediately or shut off the room until you do, see that you have a supply of clean drop cloths ready to give your new floors the protection they deserve.—J. Modroch.

Rack Holds Sanding Belts



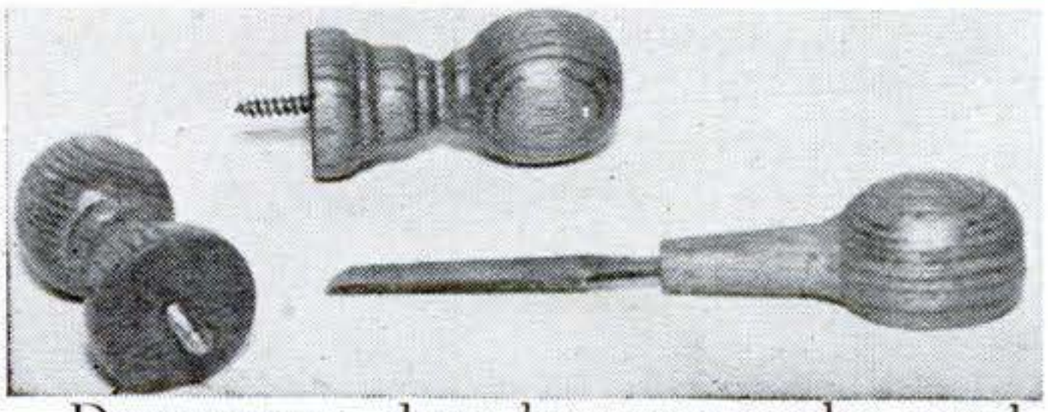
Belts for power sanders can be graded and stored in a rack made by gluing slotted dowels into holes in a wood backing board. The distance between holes and the length of the dowels will depend upon the size of the sanding belts that you have on hand.—J. A. Richards.

Pin Keeps Disks Centered



Abrasive paper often shows a tendency to slip off the center of a disk sander due to pressure and centrifugal force. On sanders that have a recess between the end of the motor shaft and the face of the disk, a dowel with a slightly projecting brad point may be driven into the opening. Glued paper punched over the point will remain firmly centered.

Door Stops Become Carving-Tool Handles



Dime-store door bumpers make excellent, hand-fitting handles for small carving tools. Place the screw of the bumper in a vise and drive off the wooden portion with a mallet. Whittle or turn down the end that held the screw to about ½" dia. A metal ferrule may be slipped over this end before the tool shaft is inserted. File a flat on the spherical portion to make the grip more comfortable and also to keep the tool from rolling on the workbench. File and sand off any roughness, and varnish the finished handle.—Z. S. Gierlach.

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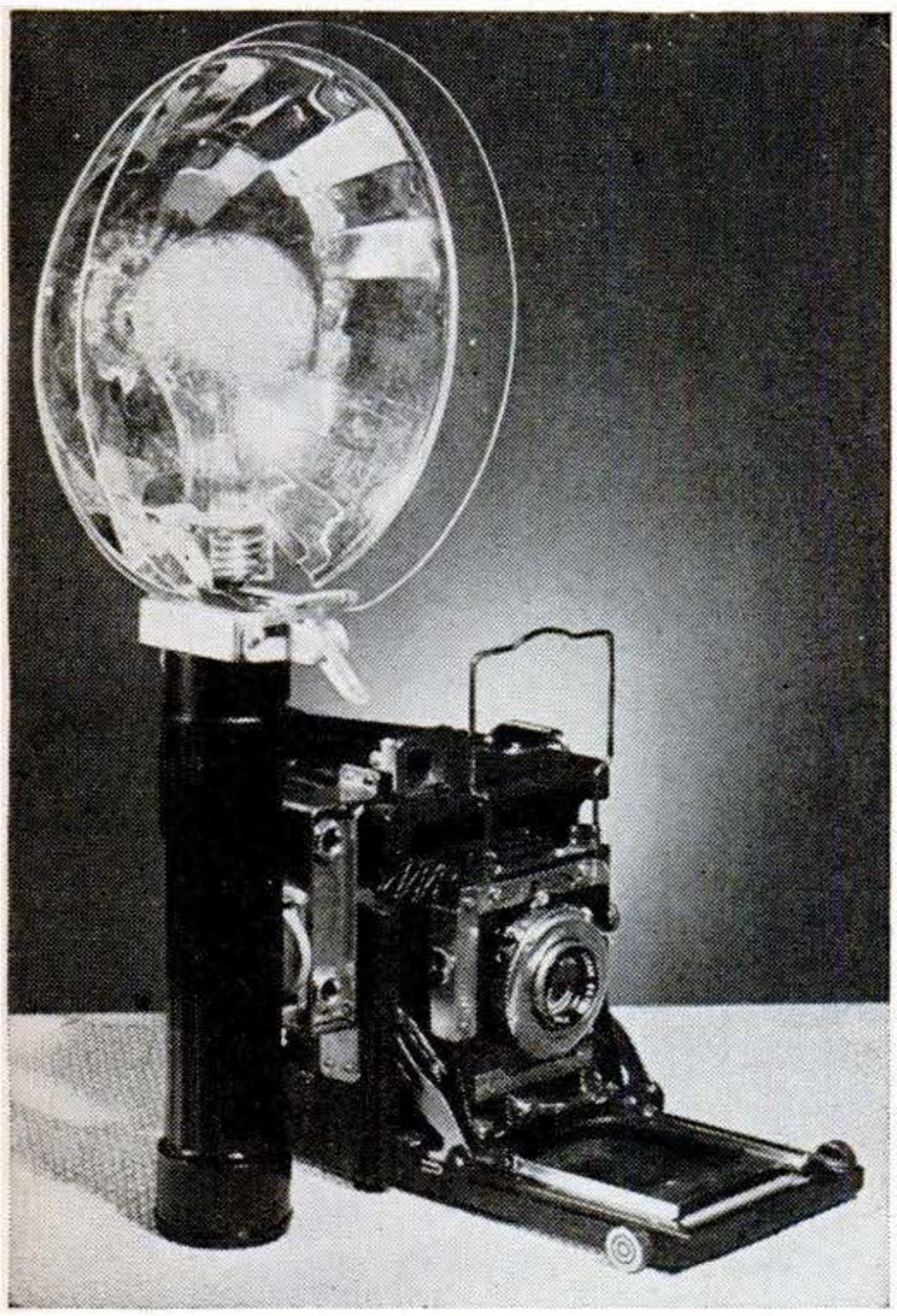
Plastic Screen Shields Flash Bulbs

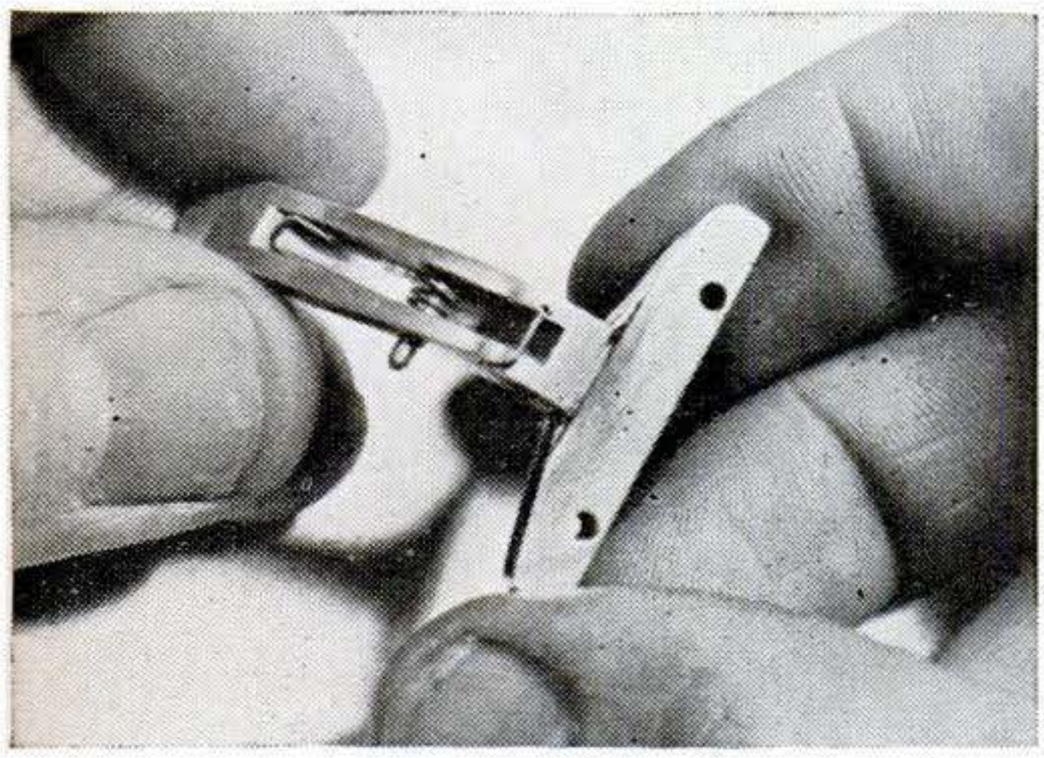


A plastic shield over the flash reflector safeguards your subject if a bulb should shatter.

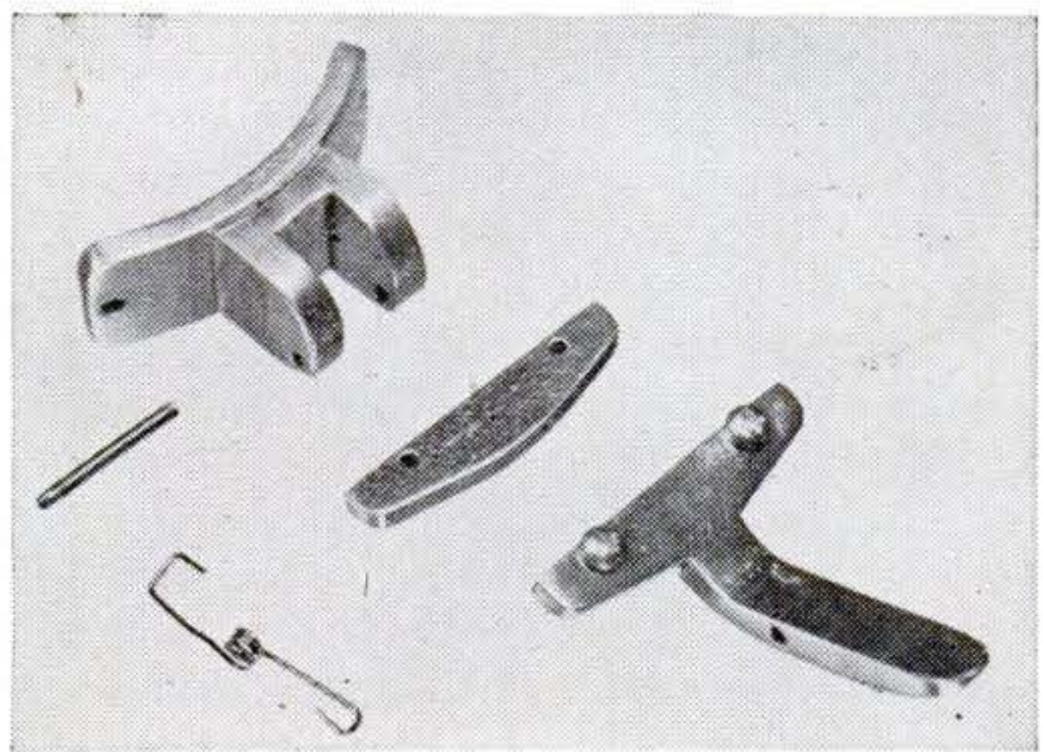
PLASTIC coatings make shattering of flash bulbs almost harmless nowadays, but you can guard against the rare hazard of an exploding one with a clear screen over the reflector. The shield can be cut from 1/16″ transparent plastic. Make it ½″ larger than the reflector, file two slots on the edge so it may be clamped to the mount, and smooth the edge with fine sandpaper.

If equipment is available, a spring trigger for lowering the disk and a bracket for attaching it to the battery case may be machined from dural, the U-shaped part of the bracket being either milled from a block or bent from ⅛″ sheet.

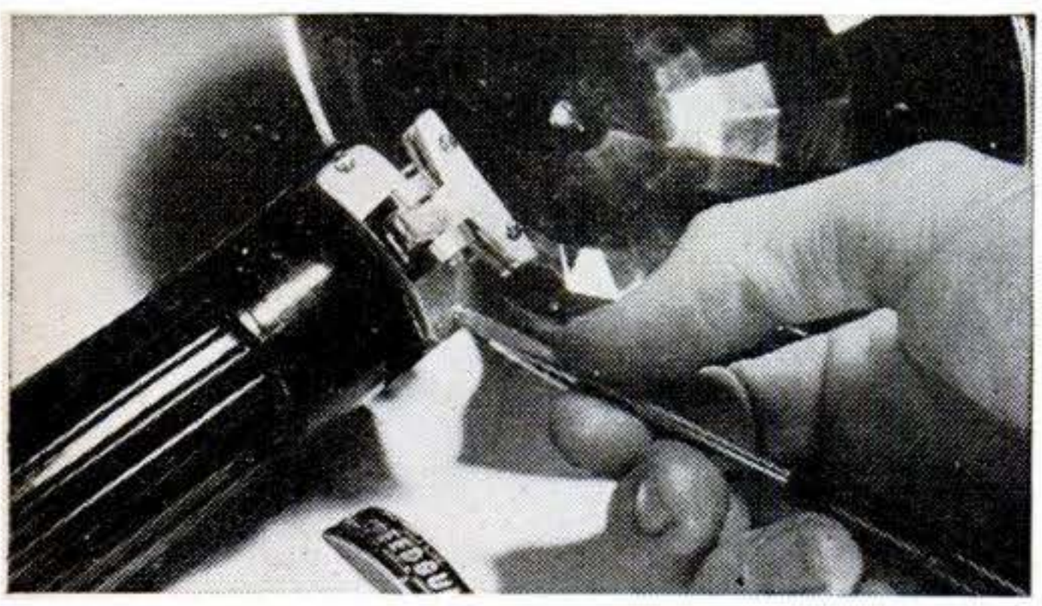
As suggested in the drawing at the bottom of the page, a trigger also may be bent from sheet brass or galvanized iron—or, simpler still, a small spring hinge may be used. With this, it will be necessary to shape a saddle to attach the hinge to a round battery case.—FRANK McCARTY.



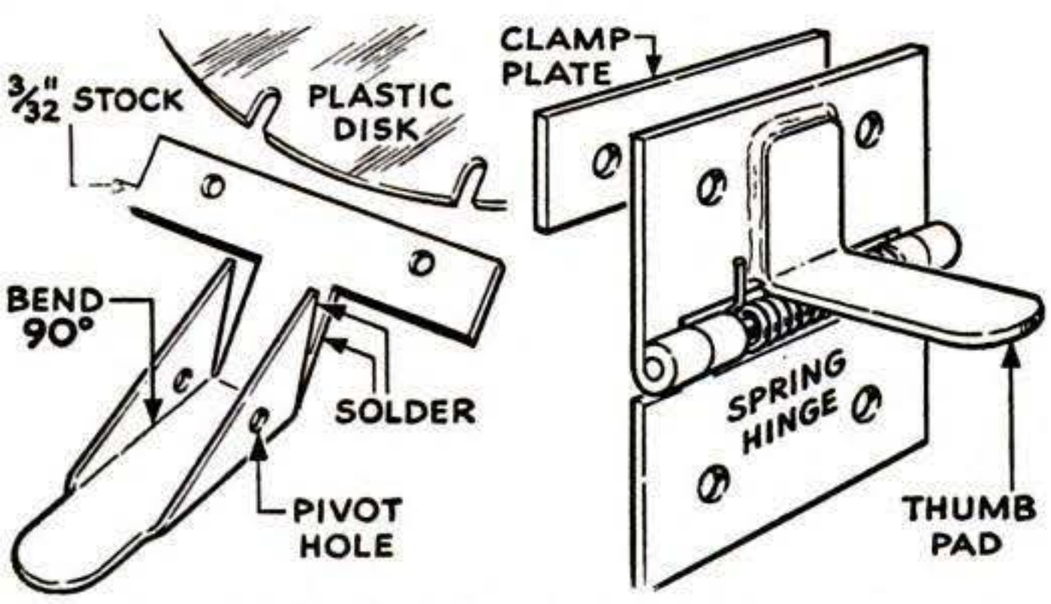
A spring in a groove under the trigger keeps the disk up, but allows easy bulb replacement.



All parts of the bracket and trigger except the spring and pin may be machined from dural.



A bracket may be substituted for the nameplate on this gun. Other types may require a clamp.



Simpler methods of making a trigger are seen here. A saddle is required to mount the hinge.

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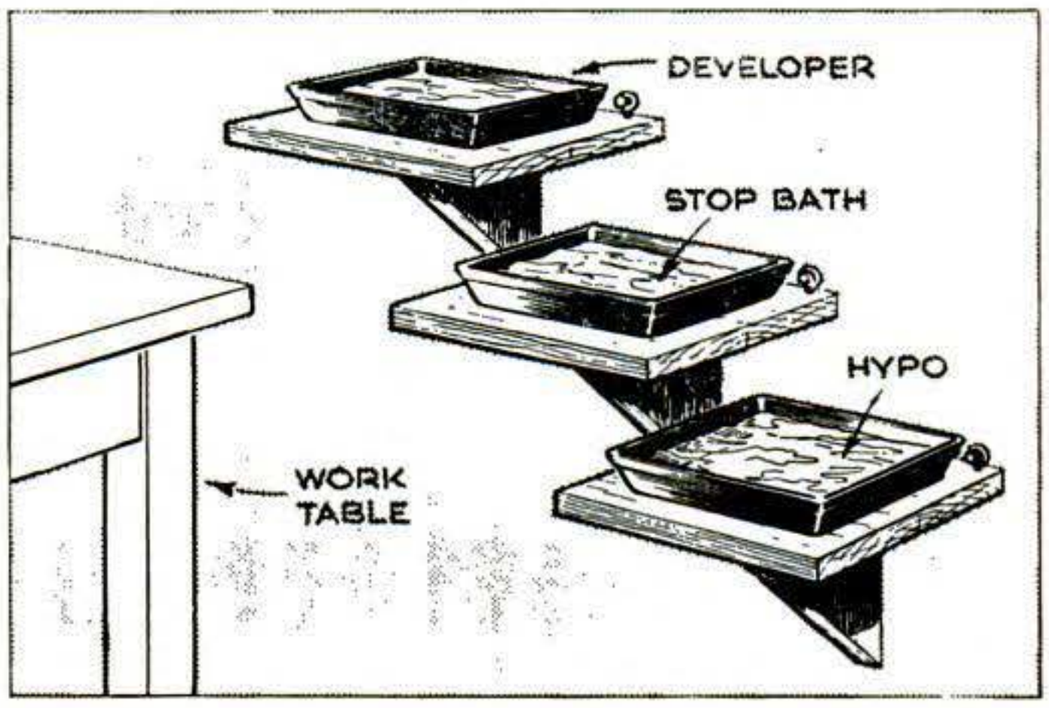
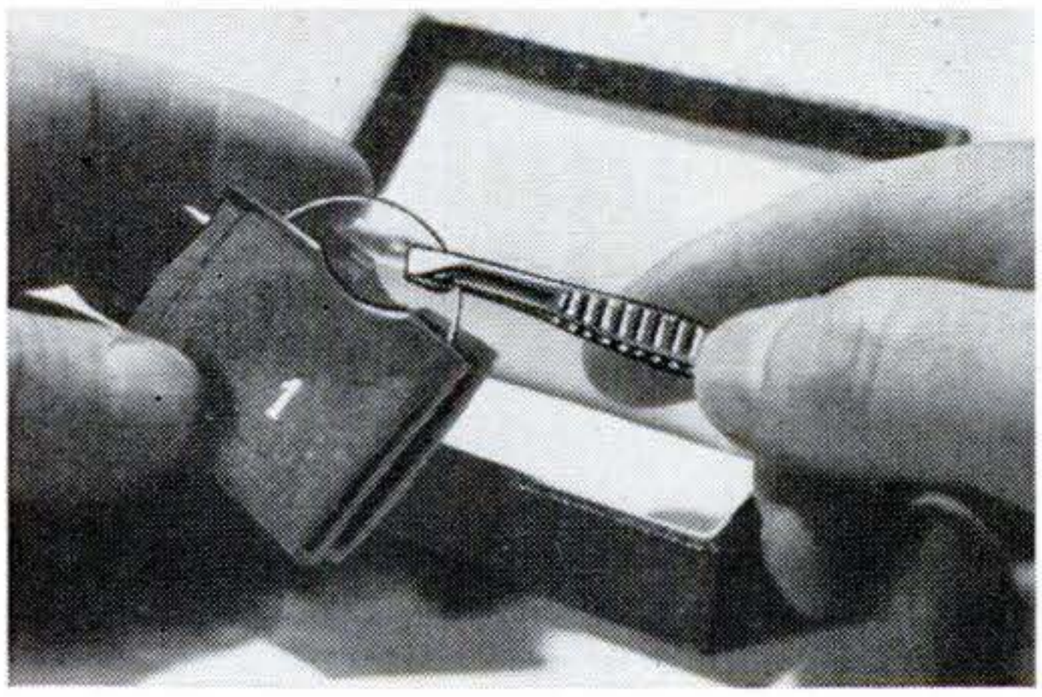
PHOTO IDEAS and EQUIPMENT

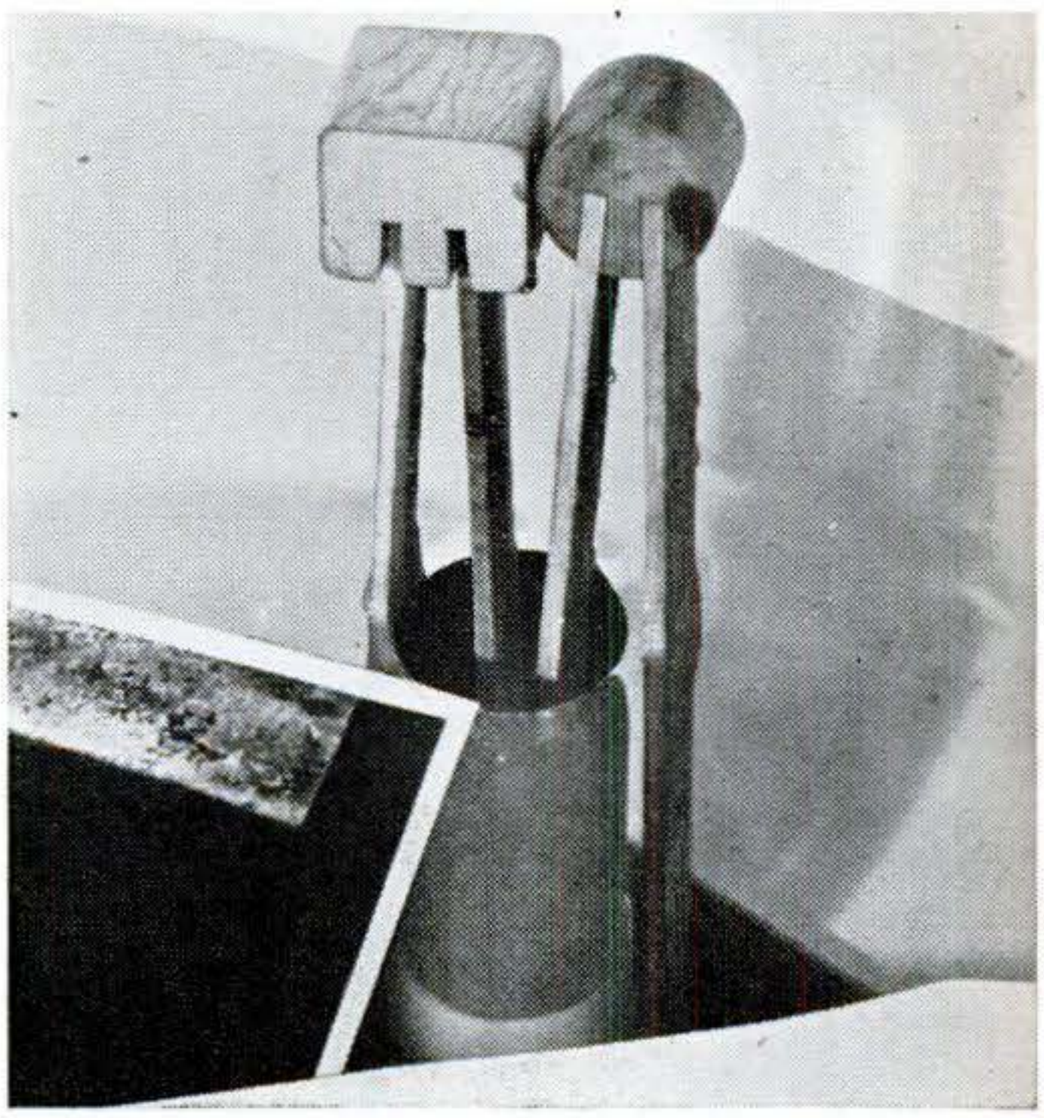
Adaptor Improves Camera. Made of aluminum, this adaptor permits the use of Graphic-type double cut-film holders, as well as film packs, on cameras of the Recomar, Voigtlander, and Ikon type. When the film holder is withdrawn, the ground glass is automatically held in focusing position. The Hollywood Photo Manufacturing Co., Hollywood, Calif., produces it in three sizes. The unit is priced at about $15.



Tray Shelves Save Space. In a closet darkroom where space is at a premium, shelves arranged in steps on the wall will give you more room. In my case, the shelves were cut large enough to accommodate 11″ by 14″ trays and were mounted step fashion as in the drawing above. Supported by screw eyes and triangular braces, they can be taken down and stored away when not in use.—A Richard Fiske.



Handle Lens with Tweezers. Unmounted auxiliary lenses for your camera will not need wiping and polishing every time they are used if you make it a habit to touch them only with a pair of tweezers. This will avoid finger marks. Tape each jaw of the tweezers to keep the lenses from being scratched by contact with the bare metal.



Tongs Keep Overflow Clear. In bathtub washing of photos, the prints have a tendency to plug the outlet. This can be avoided by thrusting your print tongs down into the overflow pipe in the drain. Water will then always escape.—R. F. Donovan.

Balloons Are Useful. Toy balloons serve as dust-tight containers for camera accessories. Close them with rubber bands.

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A pinhole camera and two Press 25 flash bulbs were used as seen above to make the portrait at the bottom of the page. The hand-held bulb was placed 30″ from the model, the other 24″.

Portraits Through a Pinhole

Open-flash technique and fast film make it possible to photograph live models with a homemade camera.

By Louis Hochman

PINHOLE cameras are seldom considered suitable for photographs of a live subject because of the exceptionally long exposures required to register an image. But flash bulbs eliminate that obstacle. By using several bulbs and the open-flash technique you can produce pinhole portraits of surprising quality.

This method of portraiture offers two practical advantages. It will yield soft-

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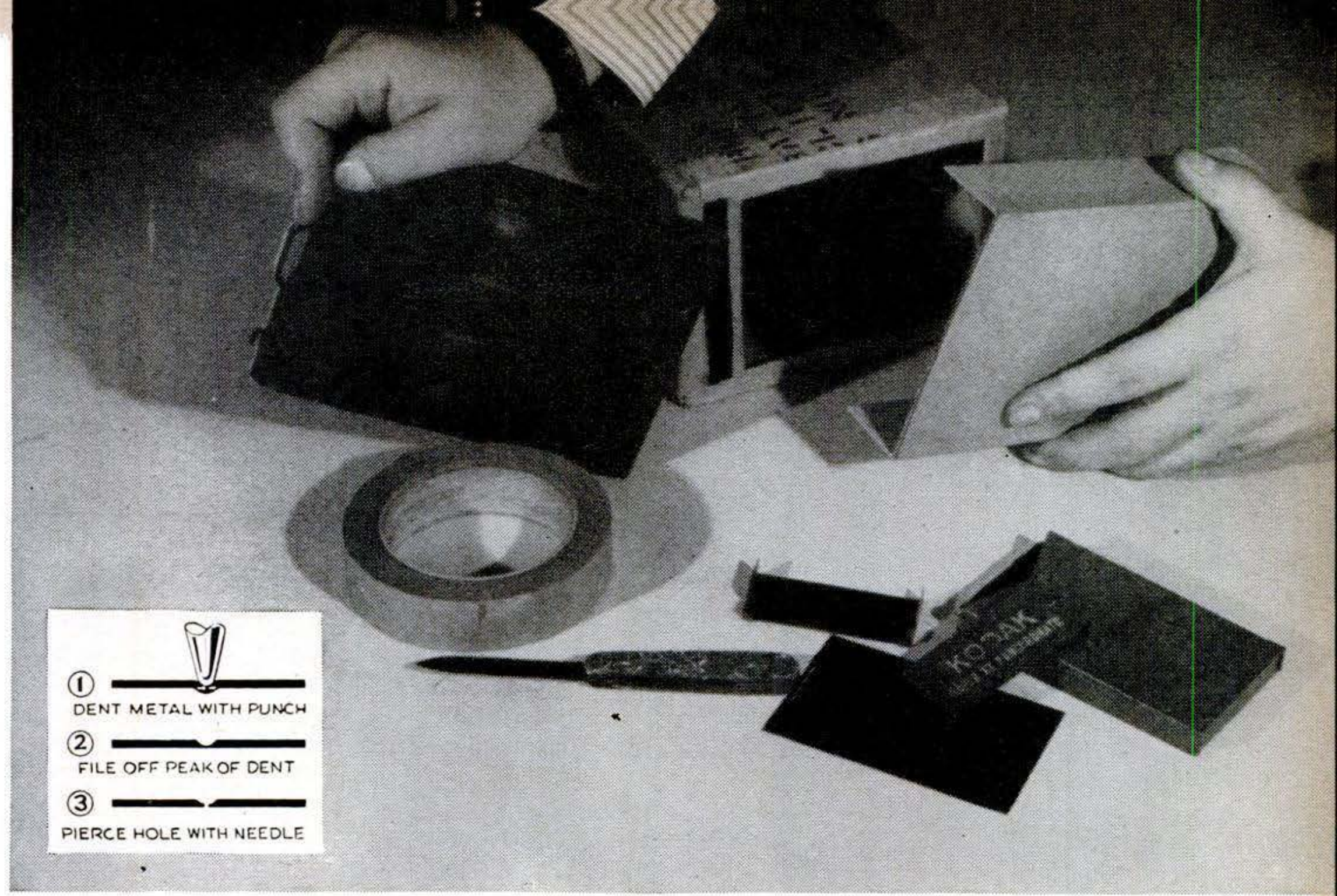
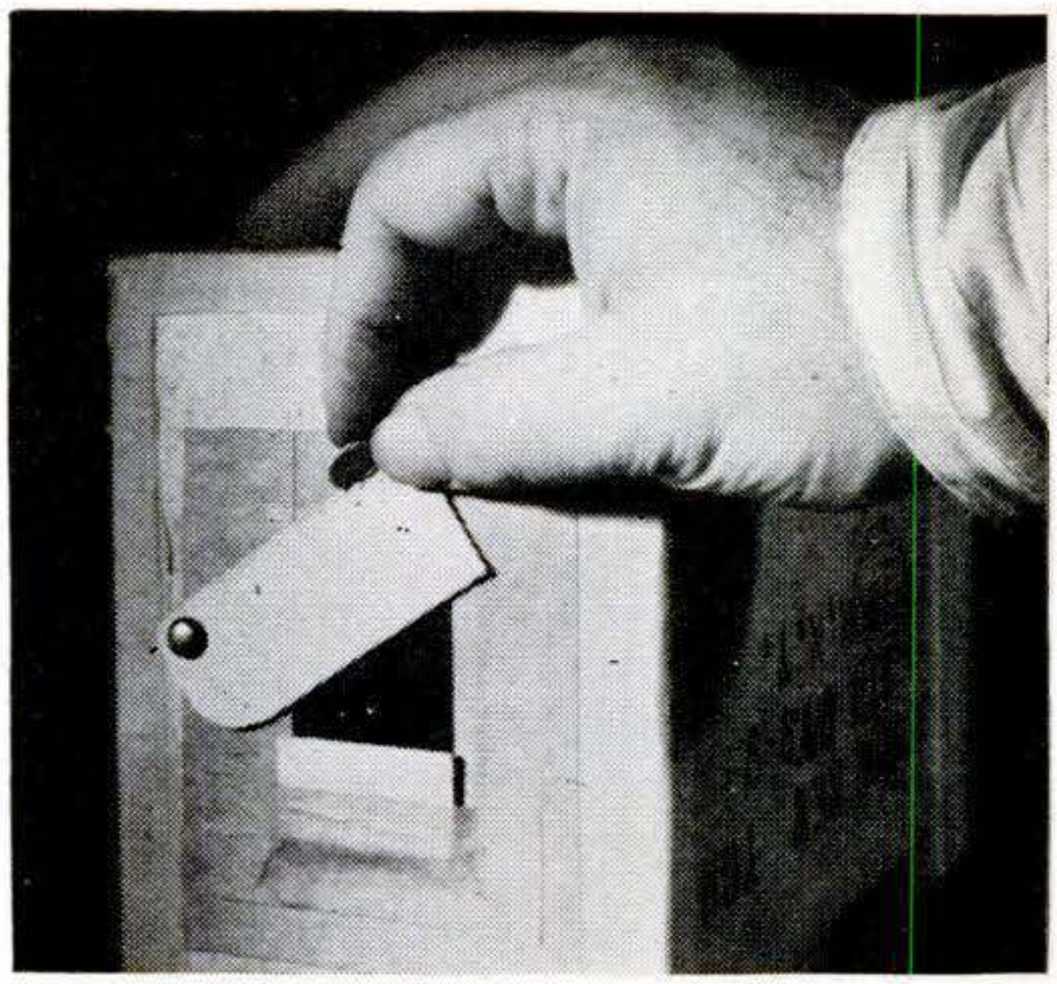


Making a pinhole camera is a simple job. You can assemble it from cardboard, as seen here, to suit the film size you intend to use. The drawing shows one way of making the pinhole.

At the back, a cover taped to the bottom and both sides, but open at the top, allows the film holder to be inserted and withdrawn.



A pivoted shutter is satisfactory for either flash shots or time exposure. A stop at the bottom retains the shutter in the closed position.

focus, distortion-free portraits of such diffused quality that no retouching is required, and, since a pinhole is always in focus regardless of its distance from the film or subject matter, widely separated subjects come out equally sharp.

Such portraits may be shot through a pinhole substituted for the lens of your regular camera or with a quickly made pinhole camera. The flash bulbs should be used in reflectors fairly close to the subject to get the maximum light output.

There are various ways of making a pinhole lens, but I suggest the method illustrated in the diagram at the top of this page. Take a thin flat sheet of brass or copper—or one of the sheets of thin metal found in film packs—and lightly punch a dent in its center with a punch or ice pick, being careful not to make a hole through

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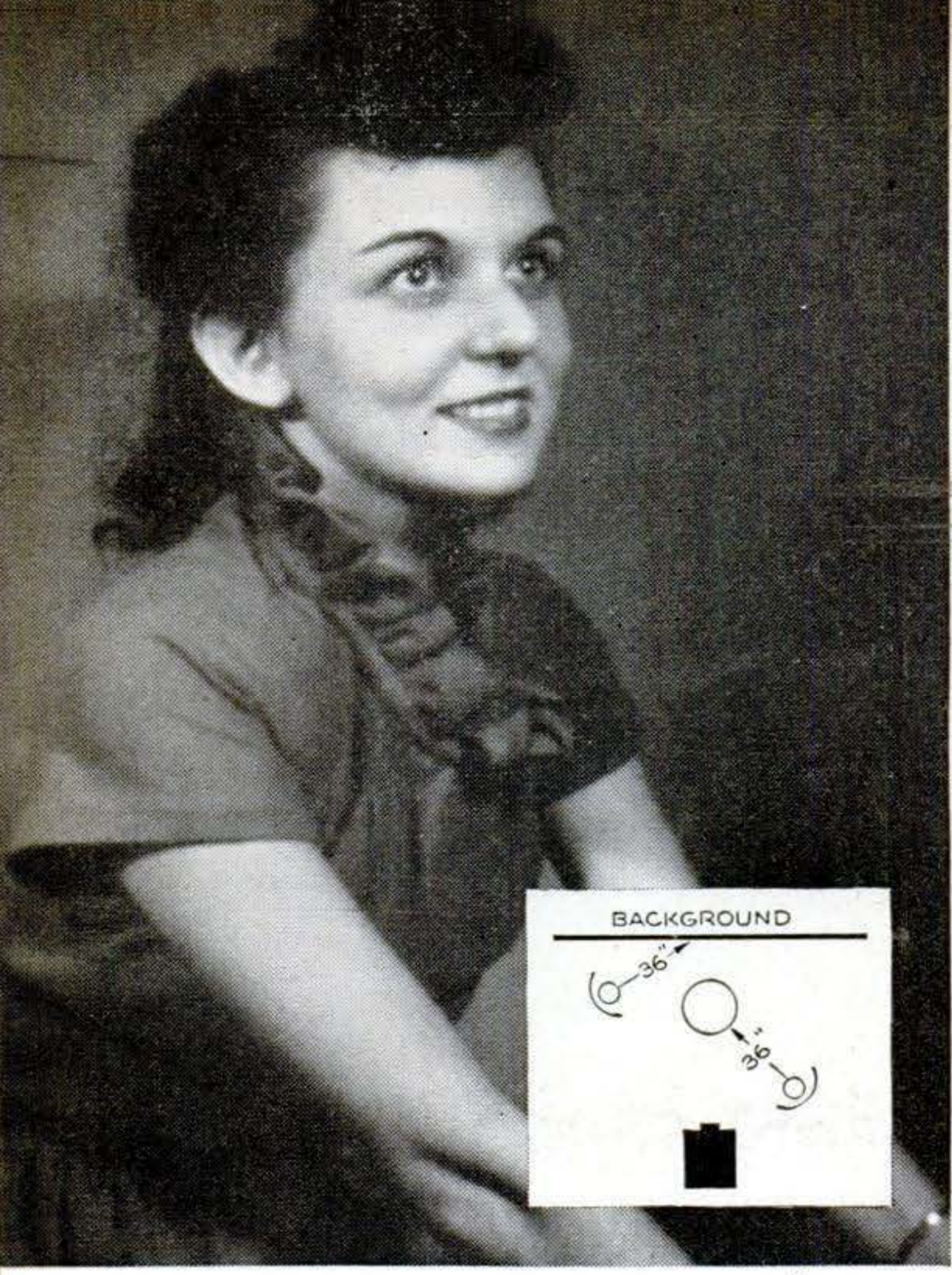

Double flash gave this soft-focus shot. The Arrow pan film was developed in D-72 solution at full strength for 10 min. at 70 deg. F. to produce a negative of good density.

the metal. Next, turn over the sheet and carefully file down the peak of the dent until the metal is almost paper thin. Then carefully pierce it with the point of a fine needle. For average all-round use, the best size probably is a hole that measures about 1/40", but the accompanying photos were taken through a hole 1/25" in diameter. A smaller hole will give somewhat sharper focus. File away any burr left by the needle.

Film Determines Camera Size

If you have a camera with interchangeable lens boards, you can attach the pinhole to an auxiliary board and use it in place of the regular lens. Or, if the lens is otherwise easily removable, the pinhole sheet might be reduced in size and taped over the aperture. For a shutter, all you will need is a pivoting sheet of black cardboard or metal that can be swung back over the pinhole between exposures.

A pinhole camera may be quickly constructed out of cardboard or wood for use with cut film. Adjust the dimensions to those of the film you intend to use. The length can be anywhere from 6" to 10", but since a greater focal length requires additional exposure time, 6" will be a good choice. Give the inside of the box a coat of dull black paint.

Wire Viewer Aids Framing

Adapt the back, or focal plane, of the box for cut-film holders by cutting a rectangular hole slightly larger than the picture size of your film. Cement a ½" strip of black velvet above the top edge of the hole to serve as a light trap. Fit a boxlike cover, such as a film carton with one end cut off, snugly over the back of the camera. Tape it to the bottom and both sides, but leave the top open so a film holder can be slipped in. It may be best to install this back while a holder is in place so as to assure a light-tight fit.

Tape your pinhole lens over a hole cut in the front of the box and equip it with a pivoting shutter. If you wish, a wire viewer may be placed on top of the camera as an aid in framing your shots.

To get an idea of the angle of view provided by the pinhole, you can attach a ground glass to the back of the camera with the back cover off. Put an unshaded lamp bulb in front and shut off all other lights. With the camera fixed, move the bulb about, noting the extremes at which its image vanishes. It's well to make a table of the field covered at various distances.

Portraits Shot with Midget Bulbs

Although it is possible to take a satisfactory pinhole portrait with only one flash bulb, two or more will give better results. Locate the reflectors 24" to 36" from the subject or background. Use only the fastest panchromatic films and give them extra development to force as much density as possible into the negative. Suitable films include Ansco Triple-S Pan, Eastman Tri-X Pan, and Eastman Sports-Type Pan. Development can be carried out with DK-60a or straight D-72 stock solution. It also may be necessary to double or triple the developing time to get sufficient density. The portrait examples accompanying this article were developed in stock D-72 solution for 10 min. at 70 deg. F. The above films and developing technique will produce good negatives when two midget (G.E. No. 5 or Press 25) flash bulbs are located 36" from the subject or the area being illuminated. Larger bulbs can be used at proportionately

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greater distances, or if shot at 24″ to 36″, less vigorous development will be required to get a printable negative.

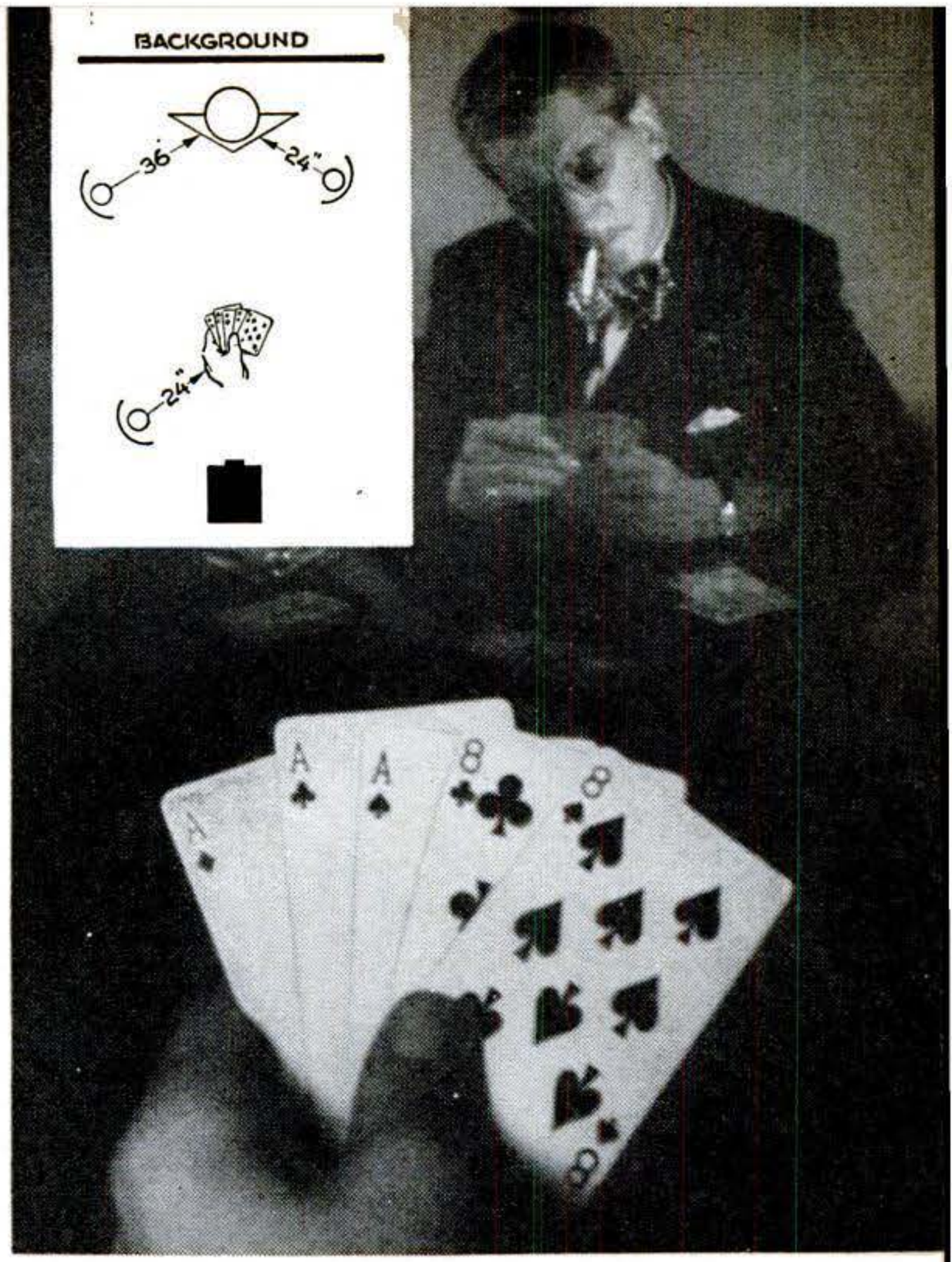
You may also want to try a few time exposures indoors with photofloods. A little experimentation will show the necessary exposure. Although floods do not yield light of sufficient intensity for instantaneous pinhole portraiture, you may find it interesting to work out some time-exposure studies of inanimate subjects.

Determining Outdoor Exposures

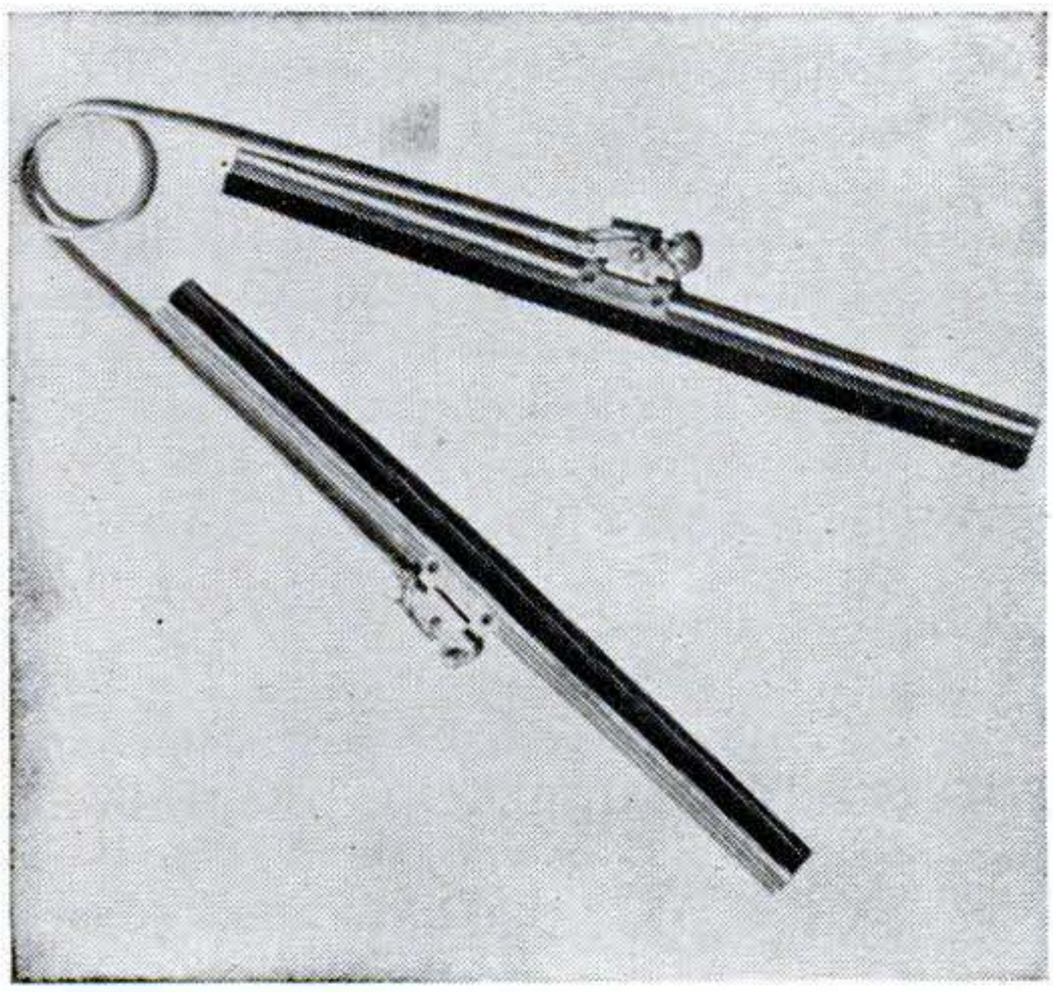
For time exposures outdoors in bright sunlight, the following method of determining the correct exposure with a 1/25″ pinhole lens may be used. First, whatever your lens-to-film distance in inches, consider that figure as your "f" value. For instance, if you are working with a focal length of 6″, your "f" value is f/6. After this has been measured, take a meter reading of the scene you intend to photograph—but read the exposure time that is given opposite your "f" value as *minutes* instead of seconds. Thus, if your meter shows that an exposure of 1 sec. at f/6 is necessary, the correct pinhole exposure will be 1 min. with a bellows extension of 6″.

It is even possible to take outdoor color shots with a pinhole. The colors may not come out perfectly true, but a few experiments should yield some surprisingly good results. As a starter, you might try a landscape or two, using an exposure of about 2 min. with the sun at your back. Only daylight color film is suitable for this, of course.

In making pinhole photos, it will be helpful to remember that extending the bellows produces a larger image from the same point of view, while shortening it reduces the image size. This makes it possible to get anything from wide angle coverage of about 125 deg. down to a telephoto effect—all with the same pinhole lens and from the same point of view. END



Extreme depth of focus is a useful characteristic of a pinhole camera. In this shot of a poker game, the full house in the foreground and the player opposite are both in focus.



Two Wiper Blades Make Efficient Film Squeegee

SOLDERED to a wire frame, two windshield wiper blades will give you a very satisfactory film squeegee. Long enough to cover any film up to and including 5″ by 7″ cut film, the blades will remove more water than the usual sponge, thus shortening the required drying time.

The frame may be bent from No. 8 gauge wire. Form a loop midway between the ends of the two arms. This will help maintain even pressure on the film during use, besides keeping the blades in a normally-open position. Such blades will not scratch the film.—WILBER H. FULKER.

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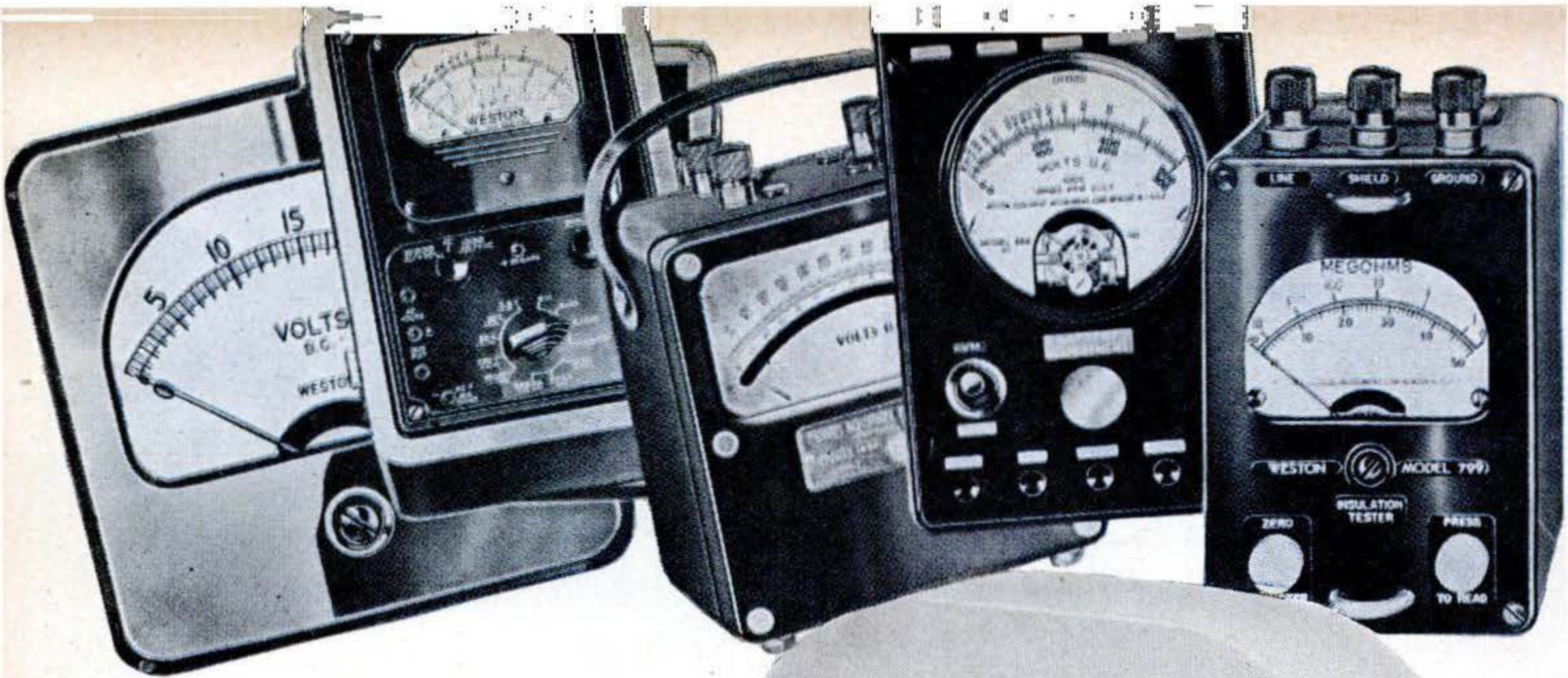
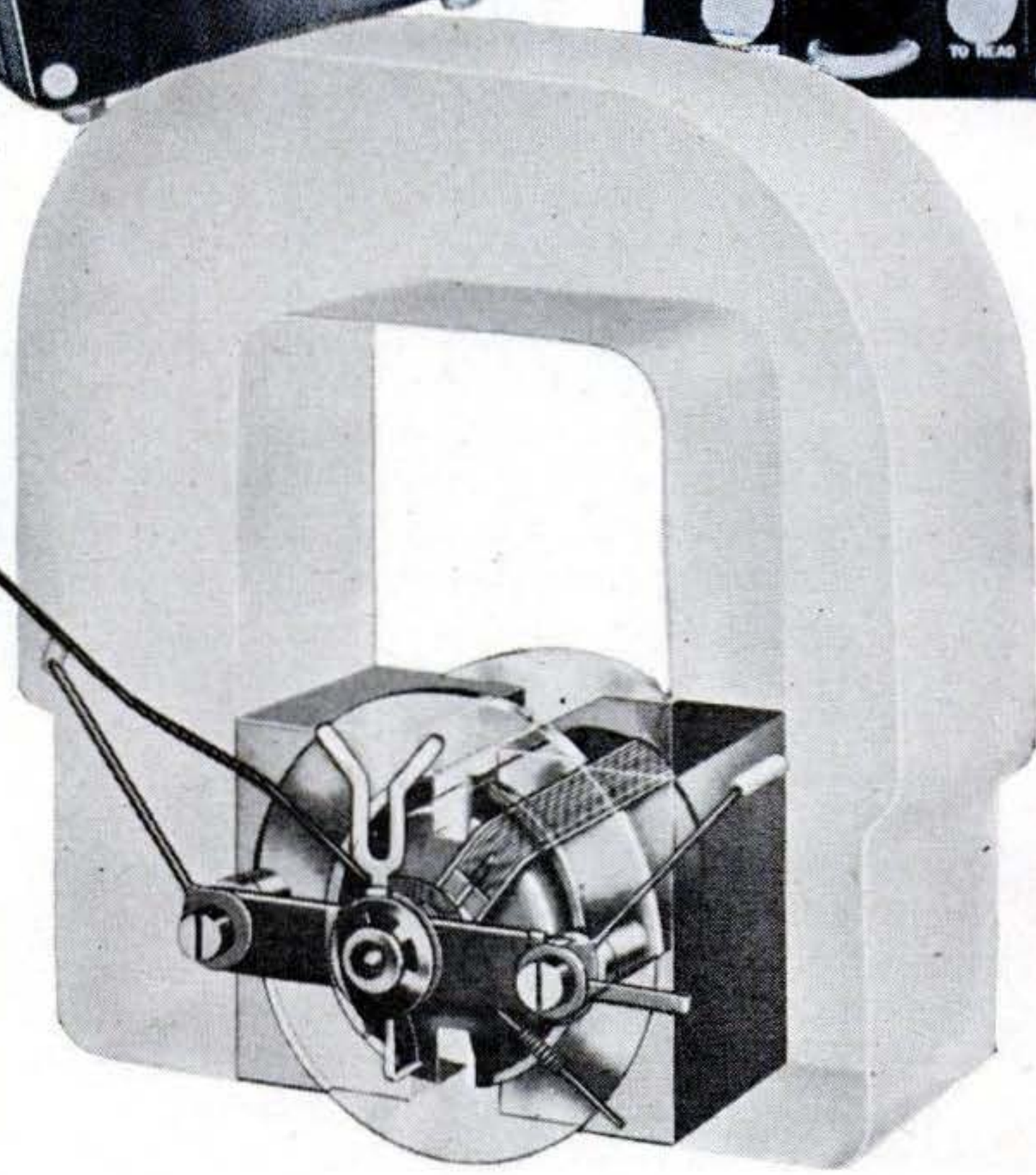


Meters Clock Electricity's Flow

Part I

By Gilbert Sonbergh



A D'Arsonval movement, shown here in phantom, indicates DC when the coil is energized.

FOR THE electronic experimenter, there's one tool that's just about as essential as a soldering iron—a wide-range AC-DC volt-ohm-milliammeter. If you work or play with electricity and have graduated out of the doorbell-and-dry-cell stage, you'll use such a meter to find accurate values of voltage, current, and resistance. Beyond these basic applications, your meter will also tell you a lot about the impedance, inductance, and capacitance of coils and condensers; it will help test tubes and do general trouble-shooting; it will serve as an easy way of measuring output in voltage, decibels, or watts; and it will permit accurate determination of input to amplifiers and other apparatus.

Once you have a good understanding of the relation between volts, amperes, and ohms, you can build yourself one of these almost indispensable tools around any fairly sensitive D'Arsonval movement. To the beginner, it may seem to be asking a lot of one meter to measure such different things, but actually it has to measure only one to tell you all three. The ironclad magic of Ohm's Law does the rest. This law specifies that a current of 1 ampere will flow when a potential of 1 volt is applied across a resistance of 1 ohm. If the meter can measure any one of these, a second one being known, the third always pops up as the answer.

Heart of the standard DC meter, the current-measuring D'Arsonval movement consists of a lightweight pointer attached to a pivoted coil of fine copper wire. Mounted between jewel bearings, the coil is free to rotate in the field of a permanent magnet.

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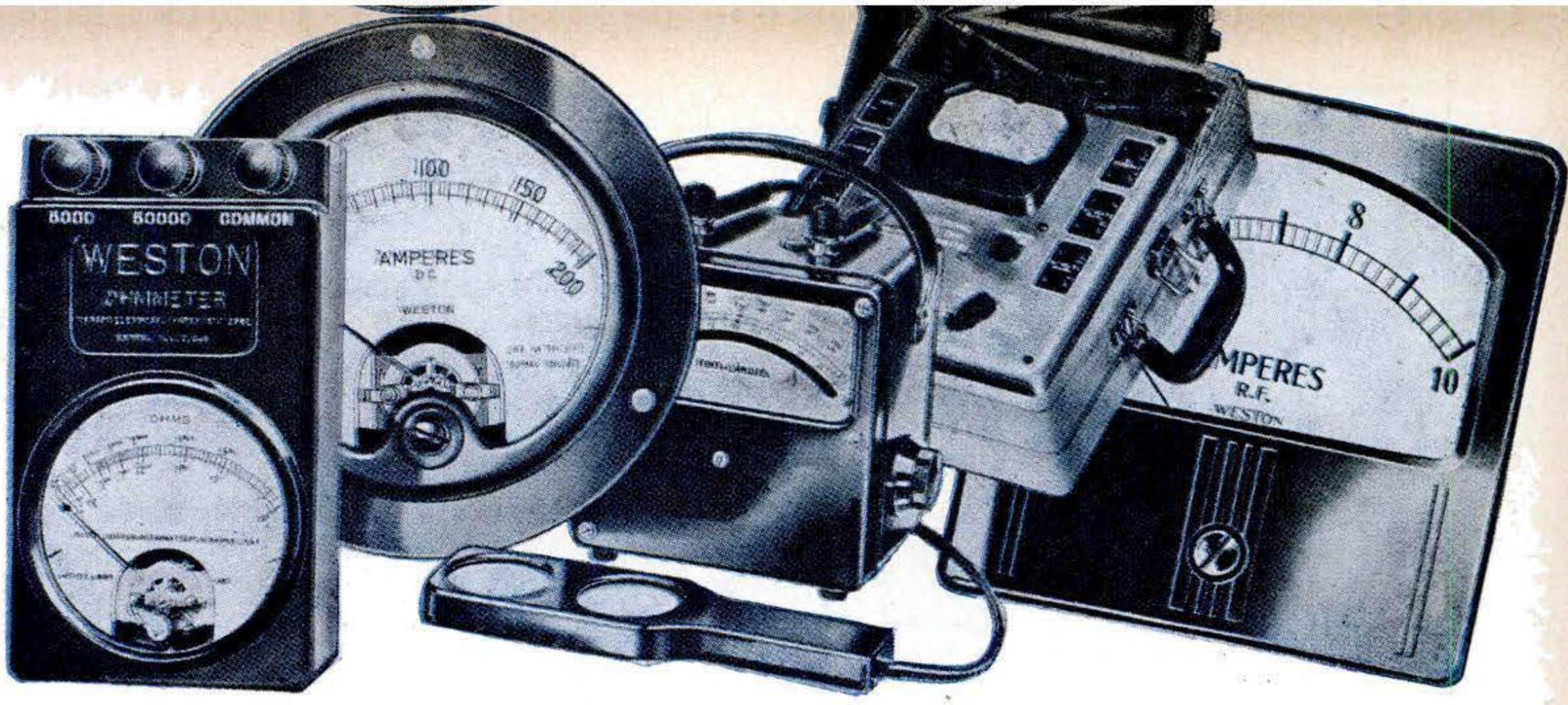

Photos from Weston Electrical Instrument Corporation

Two delicate hairsprings carry current to the coil and also serve to position it so that the pointer is normally at zero on the scale. When current flows in the coil, interaction of the lines of force produces a torque. This torque rotates the coil and its pointer to a position where it balances the opposing torque of the springs.

For greatest versatility, multimeter movements are usually designed to react to very low values of current, but it's a simple matter to increase the current range of such a meter. Let's say it has an internal resistance (Rm) of 100 ohms—that is, the moving coil itself offers this resistance to the flow of current—and that 1 milliampere (.001 amp.) will deflect the needle all the way across the scale.

In order to double the range of such a meter, all you need to do is put a 100-ohm resistor in parallel with the meter to by-pass half the current, and multiply the reading by two. Shunts of lower resistance increase the current-handling capacity still more.

Volt and Ohmmeters

Milliammeters plus Ohm's law also add up to volt and ohmmeters. By measuring current, the former tells you how much voltage is being applied to a circuit of known resistance. Take the same 0-to-1 ma. movement with an Rm of 100 ohms. You want to convert it into a 0-to-10 volt meter. This means merely that 1 ma. must flow through the coil when you put 10 volts across the meter. But its own resistance is far too low and will pass too much current, so extra resistance is added. We know from Ohm's law that a potential of 10 volts will send a current of .001 amp. through a resistance of 10,000 ohms. To the 100 ohms of the meter itself, 9,900 ohms must therefore be added in series. For measuring AC voltages, a D'Arsonval meter must also be equipped with some sort of rectifier that will serve to convert to DC that portion of the current needed for the operation of the meter.

The conventional ohmmeter, as has been said, is also an ammeter in disguise. A suitable voltage is applied to meter and resistor which permits, say, 1 ma. to flow when the circuit is completed. Thus, if you short the test prods the needle goes all the way across the dial to zero ohms. But when you put additional resistance in series with this circuit, you decrease the current. The higher the resistance that you're measuring, the lower the current that gets through. Unlike other values, resistance is lowest at the right, highest at the left end of the dial.

A variation of the usual resistance meter is the shunt ohmmeter used to measure low ohmic values. This is a milliammeter of known internal resistance that is energized to read full scale. When the unknown resistance is shunted across the circuit, current through the meter coil drops in proportion to the ratio between the fixed and unknown resistances.

Measuring a Meter

In order to build a multitester, it is first necessary to know the characteristics of the movement you plan to use. The easiest way to determine the current required for full-scale deflection is to connect the unknown meter in series with a meter of known accuracy, a variable resistor, and a voltage source. This is illustrated by the closed circuit shown on page 204. Since the cur-

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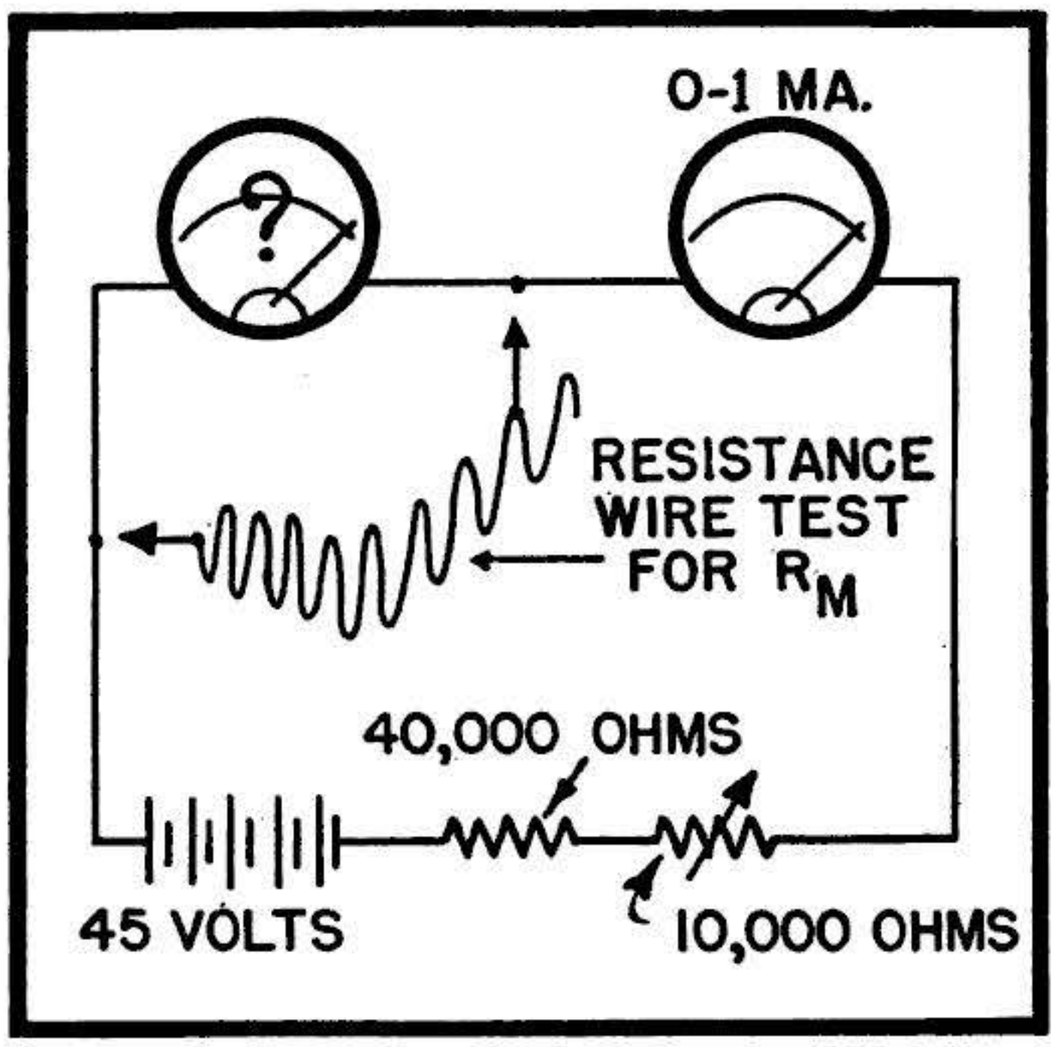

The internal resistance of a meter movement and the current required for full-scale deflection can be determined with this setup.

rent is the same in all parts of a series circuit, all you need do is adjust the variable resistor until the unknown meter reads full scale. The amount of current required to produce this deflection may then be read directly on the known meter.

Using the same setup, you can determine the internal resistance of the movement. With the variable resistor adjusted to make the meter read full scale, shunt the meter with fine resistance wire of, say, 10 ohms per foot as indicated by the wavy line. Add wire until the meter reads half scale, and reset the variable resistor as needed to keep the total current (shown on the second meter) constant. When the wire shunt and the unknown Rm are equal, half the current goes through the meter and the other half through the wire. Measuring the length of the wire then tells you the Rm of the meter. Use accurately labeled resistance wire.

Sensitivity, another characteristic of the movement, may become important in some applications of multitesters. A meter that yields full-scale deflection with a current of 1 ma. is said to have a sensitivity of 1,000 ohms per volt, because 1 volt will give full-scale reading when the total series resistance equals 1,000 ohms. This ratio will apply for all other ranges, that is, 100 volts full scale will require resistance totaling 100,000 ohms.

For electronic work, meters should have at least 1,000 ohms per volt sensitivity to avoid "loading" circuits under test.

When building a multitester, it is usually a good idea to complete the ohmmeter section first so that it can be used in the selection of other resistors. The accuracy of a series ohmmeter depends primarily upon the accuracy with which the total circuit resistance is known. Since the voltage of batteries, even when new, varies widely, some means of zero adjustment is always provided. With the test leads shorted together, zero ohms, or full-scale deflection, is adjusted by means of the variable resistor shunted across the meter.

Bear in mind that any series ohmmeter,

FORMULAS FOR MULTIMETERS [*ELECTRICITY*]

General Forms for Ohm's law

(1) $I=\frac{E}{R}$

(2) $R=\frac{E}{I}$

(3) $E=IR$

(4) $P=IE=I^2R=\frac{E^2}{R}$

Where **I** is current in amperes.
R is resistance in ohms.
E is potential in volts
P is power in watts.

To Calculate Milliammeter Shunts

(5) $R=\frac{Rm}{n-1}$

Rm is internal resistance of meter (plus resistance of series-connected fuse).
n is range-multiplication factor (to convert from 1 ma. full scale to 10 ma., n—1=10—1=9).

To Calculate Voltmeter Multipliers

(6) $R=Rm(n-1)$

Series-Ohmmeter Operation

(7) $R=\frac{Rs\ Ifs}{Im}-Rs$

Rs is total fixed resistance in meter circuit (including Rm).
Ifs is meter's full-scale current.
Im is reduced current during test.

Shunt-Ohmmeter Operation

(8) $R=\frac{Im\ Rm}{Ifs-Im}$

(approximation.)

POPULAR SCIENCE MONTHLY SHOP DATA

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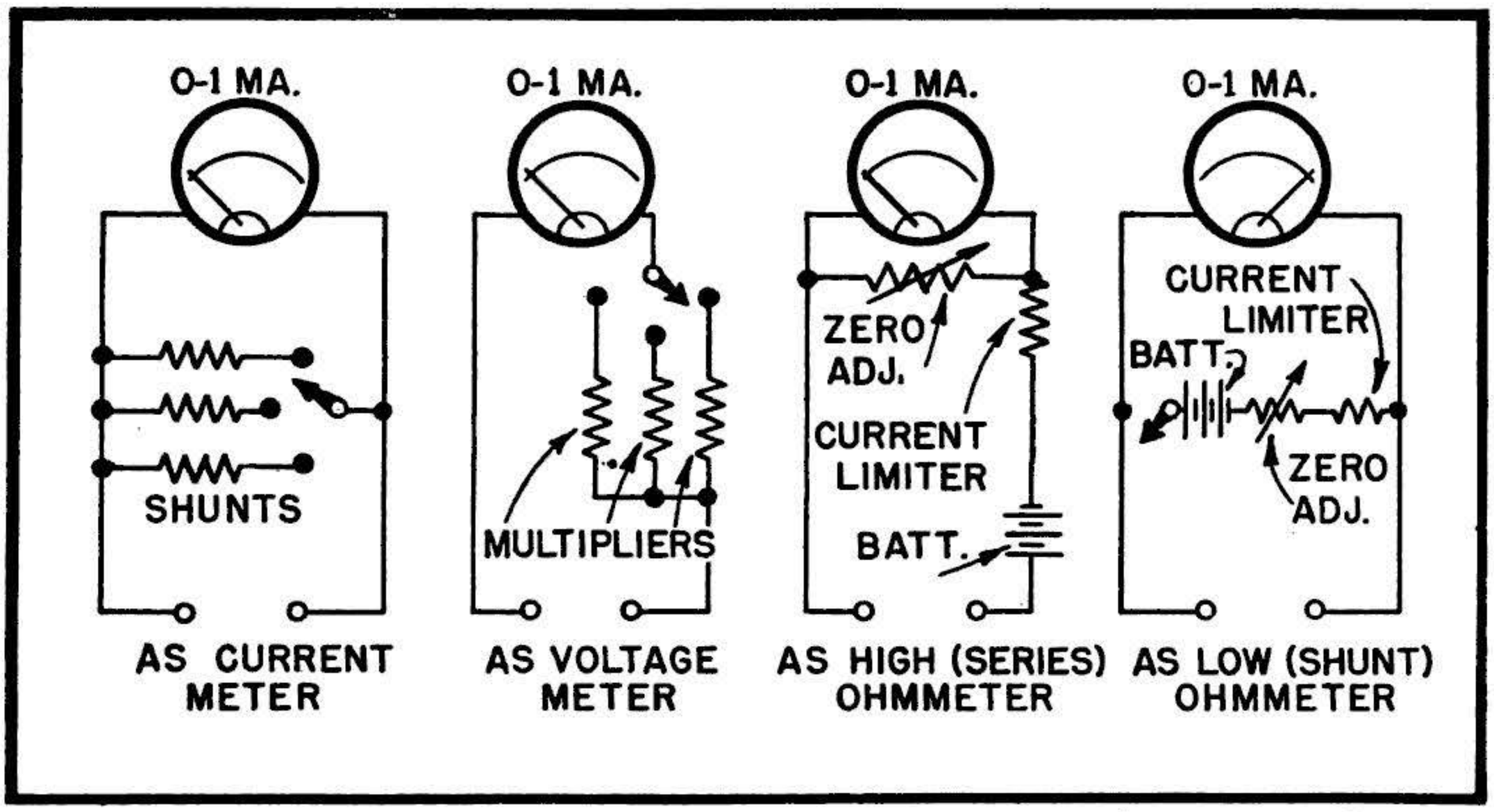

Basic Principles of V-O-M meters. Any fairly sensitive current meter will register higher values of current as well as volts and ohms if the proper resistors and energizing voltages are connected. One meter and a switching arrangement combines them into a multitester.

whether its scale is 0-100 or 0-100,000, effectively covers the enormous range from zero to infinity. This being so, the upper end of the scale—which is the lower end of the milliammeter scale—is bound to be very hard to read and increasingly inaccurate as it crowds in toward infinity. Series ohmmeters therefore, are usually peaked at the center of the dial. For a 0-1 ma. movement, standard series-ohms ranges are 45,000 ohms center scale (using a 45-volt battery and a total of 45,000 ohms fixed resistance); 4,500 ohms center scale (4.5 volts and 4,500 ohms); and 450 ohms center scale, using a total circuit resistance of 450 ohms. To calibrate or graph the dial of a milliammeter so that ohms may be read directly, use the table below; the figures are based upon these standard resistance-voltage values.

Construction notes on several multitesters will be given in a coming installment.

[TO BE CONTINUED]

OHMMETER TABLE

[*ELECTRICITY*]

For calibration of meter dial or graph sheet

Meter scale readings resulting from various values of resistance in circuit of conventional series-type ohmmeter using O-1 ma. meter with 4.5-volt battery and enough resistance (4,500 ohms) in series to make meter read full scale for zero ohms. The ohmic values for the given meter readings may be divided by ten by using O-10 ma. meter with 450 ohms, or multiplied by ten by using 45-volt battery and 45,000 ohms in series.

Ohms	ma.	Ohms	ma.
Zero	1.0	5,000	.474
100	.978	6,000	.429
200	.957	7,000	.391
300	.937	8,000	.36
400	.918	9,000	.333
500	.9	10,000	.31
600	.883	12,000	.273
700	.865	15,000	.231
1,000	.818	20,000	.184
1,500	.75	25,000	.152
2,000	.692	30,000	.13
2,500	.643	40,000	.101
3,000	.6	50,000	.083
3,500	.563	60,000	.07
4,000	.53	100,000	.043
4,500	.5		

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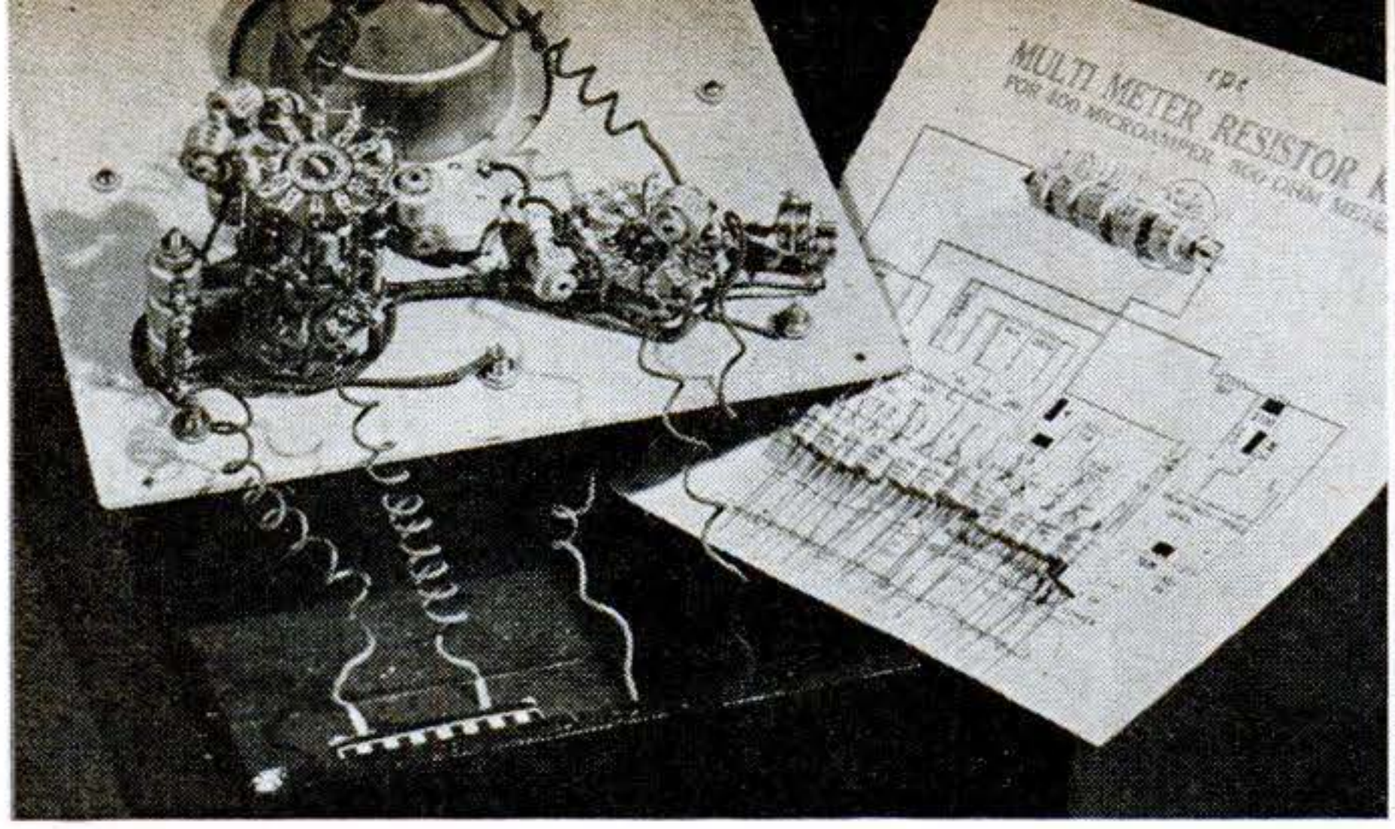
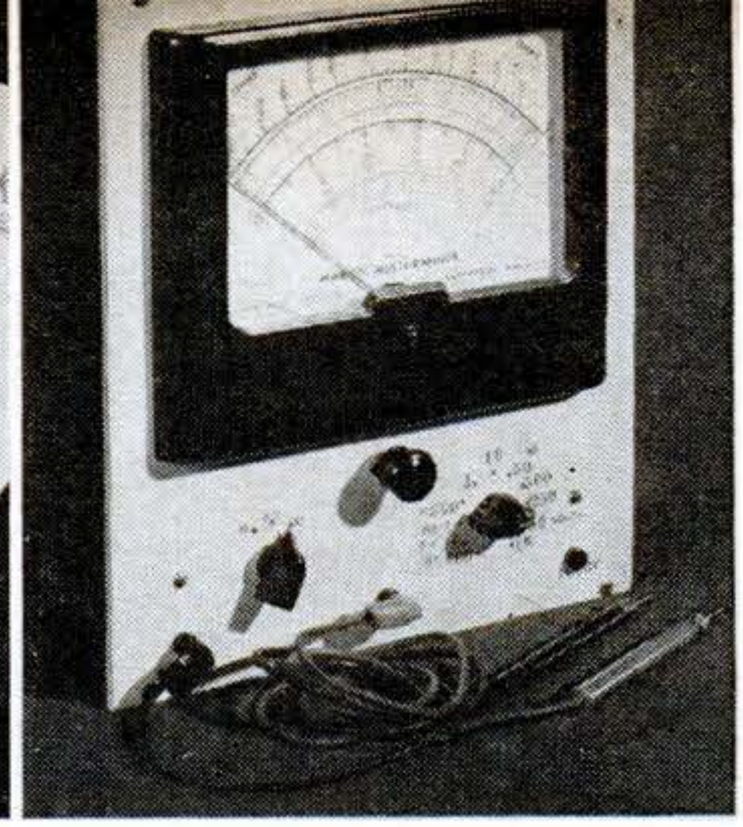
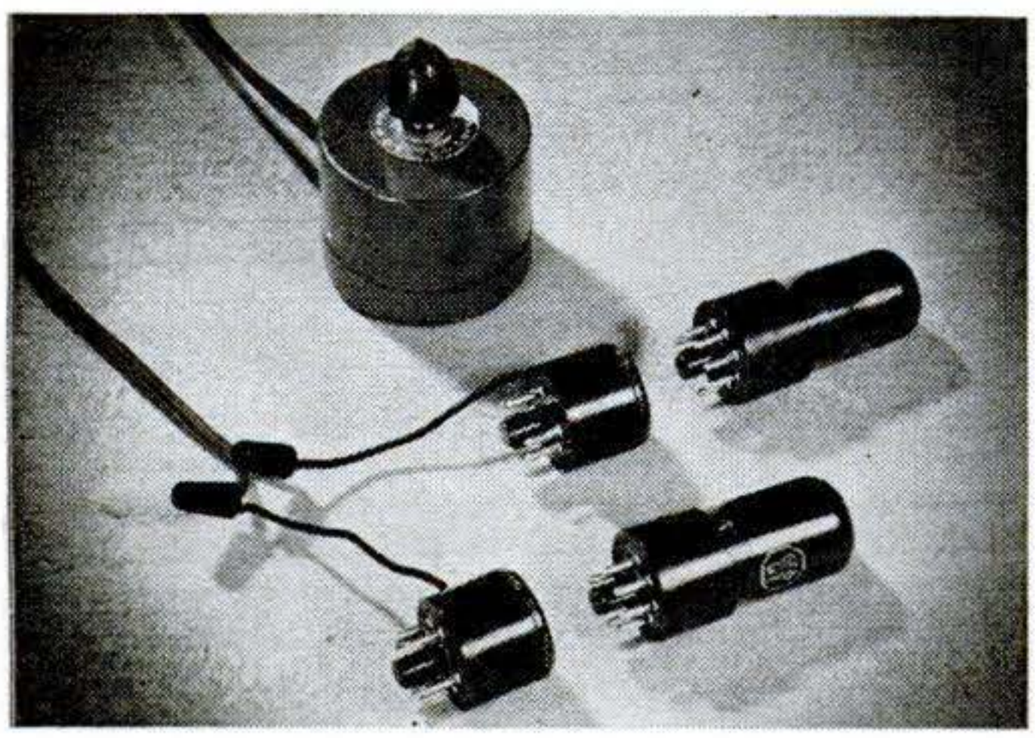
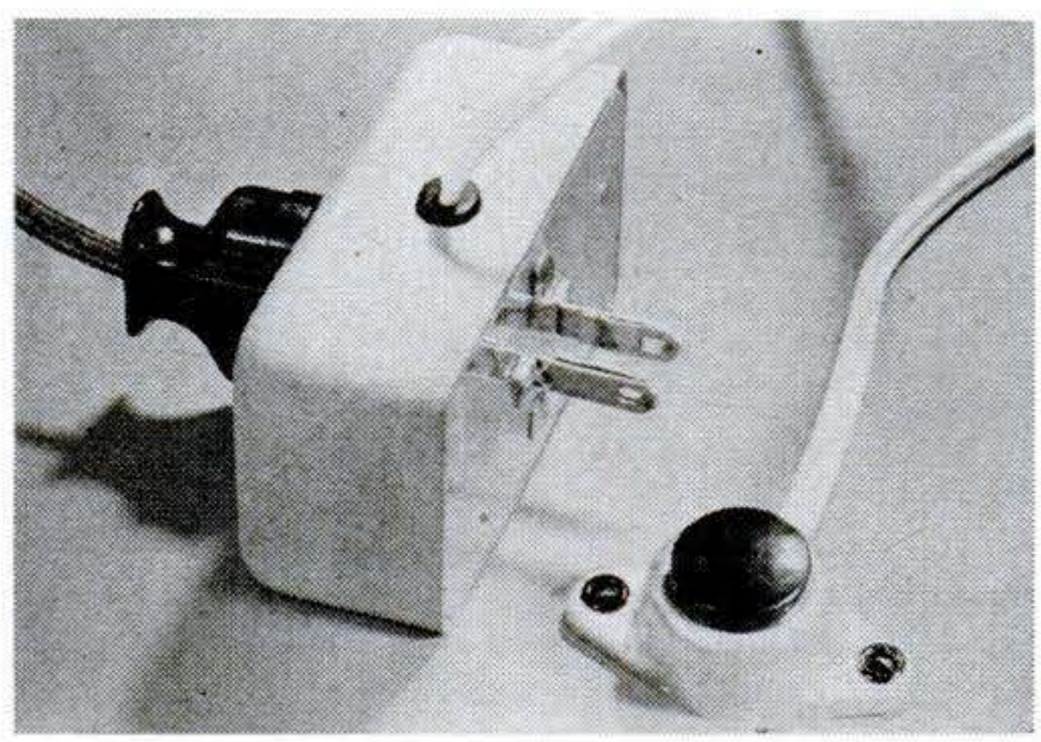




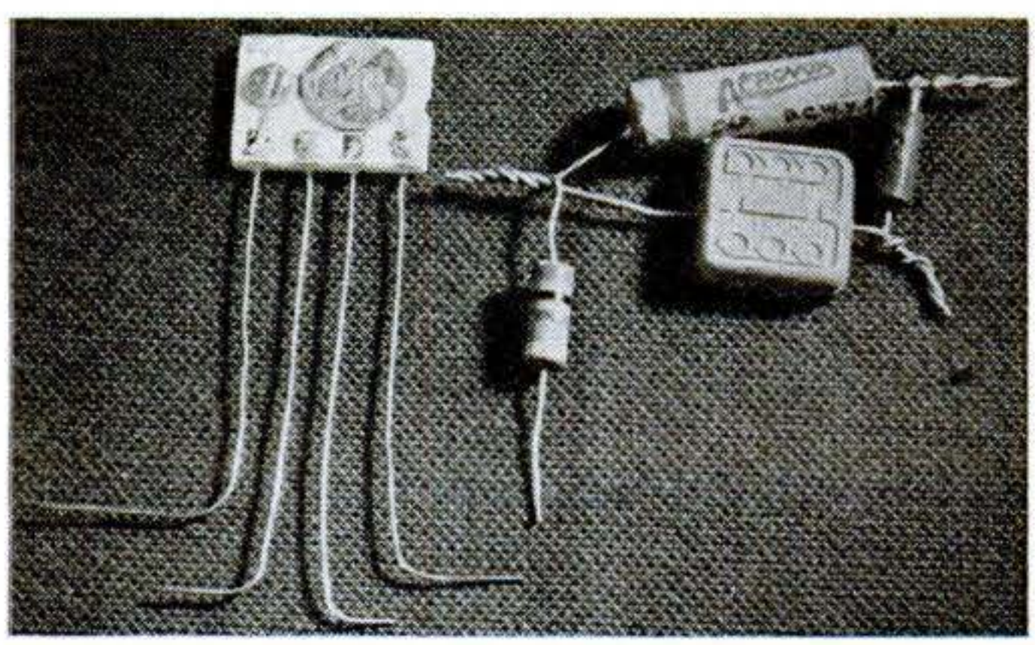
Multimeter Built from Kit. For experimenters who have shied away from the job of building volt-ohm-milliammeters because of the difficulty of obtaining matched and accurate shunts and multipliers, Resistance Products Company, Harrisburg, Pa., supplies the necessary resistors in kit form. They are furnished with a circuit diagram and are designed to match the characteristics of Marion Multi-Ranger meters. One kit, composed chiefly of wire-bound resistors, sells for about $13; another consists mostly of matched carbon pairs.

NEWS IN ELECTRONICS





Radio Listeners Enjoy Silence. With the two gadgets shown above they can have it without getting out of their chairs. A remote volume control, left, makes it possible to adjust sound level from a distance. At right is a time-delay relay that turns the radio off at the press of a button; the set comes on automatically after an interval about as long as the average commercial. The devices are made, respectively, by Earsaver, of Burbank, Calif., and Commercial Control Company, Beverly Hills.



Coupling Circuit Is Printed. A complete interstage coupling circuit printed on a ceramic plate is now being manufactured by Centralab Division of Globe-Union Inc., Milwaukee. The unit includes commonly used values of plate-load and grid resistors, and plate by-pass and coupling capacitors. Roughly equivalent components are also shown in the photo at the left. Use of the printed circuit eliminates four or five soldered joints, saves space, and cuts cost.

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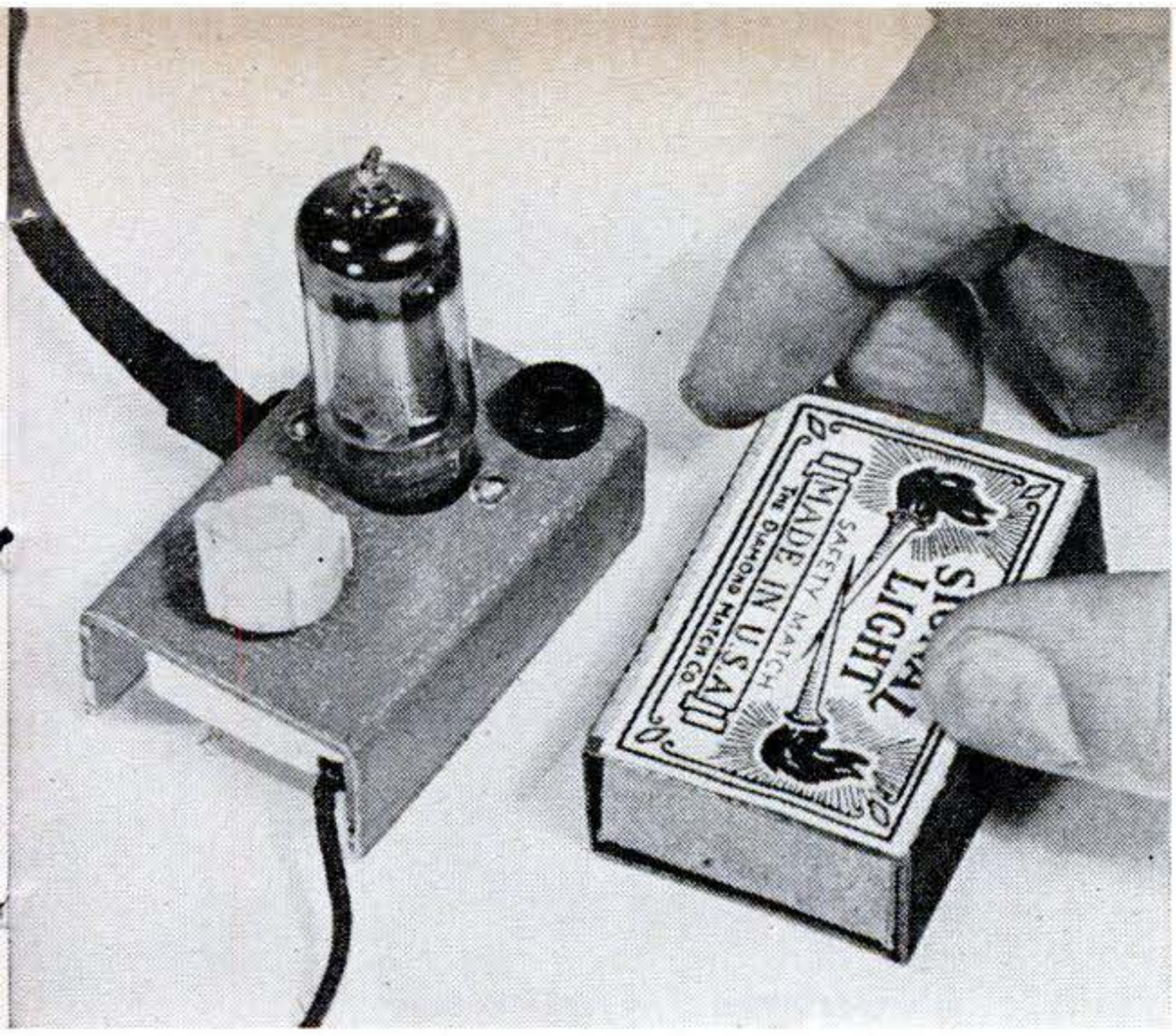
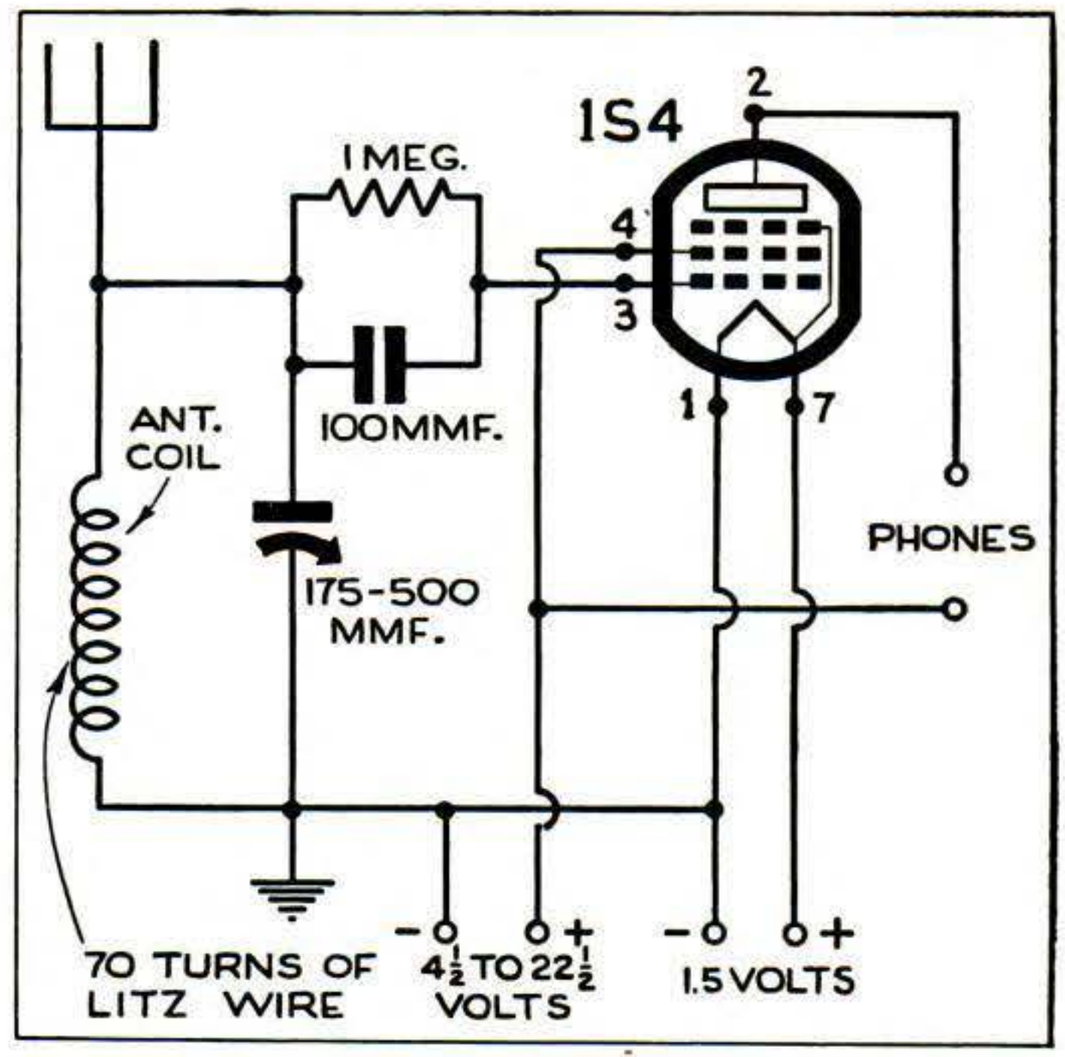


A shaft is soldered to the top of the trimmer condenser so that a tuning knob may be added.



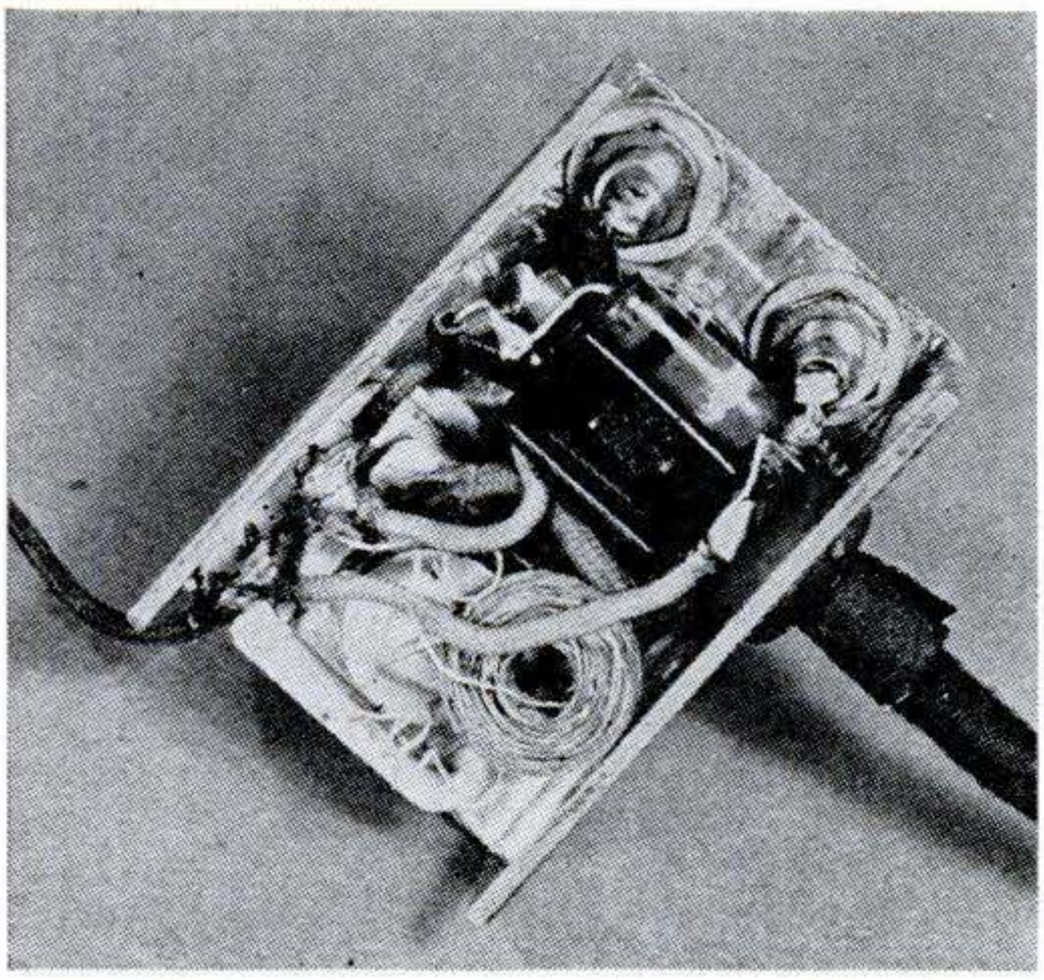
The average spare-parts box will produce most of the components used in this simple circuit.

One-Tube Radio Is Matchbox Size

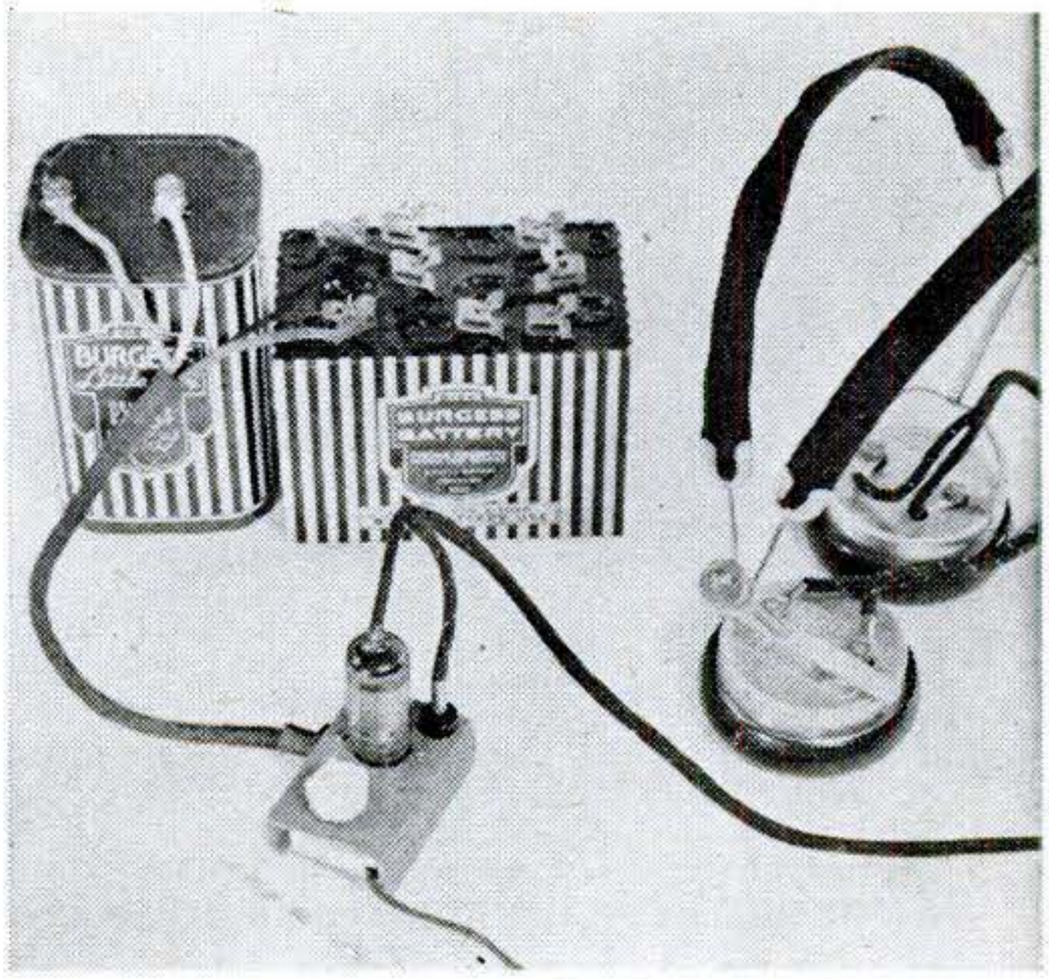
SQUEEZING a complete radio receiver down to the dimensions of a matchbox is no more than a leisurely evening's work. This set, which will readily fit in your vest pocket, is built on a ¾″ by 1 7/16″ by 2¼″ chassis made from 1/16″ aluminum.

A small trimmer condenser used for tuning, two phone jacks, and a 7-prong miniature socket are mounted on top of the chassis. Underneath are the 1-meg. grid resistor, the 100-mmf. mica condenser, and an antenna coil that is made by winding approximately 70 turns of litz wire around a pencil. Slip the coil off the pencil and impregnate it with coil dope.

Since the 175-500-mmf. trimmer will tune only a portion of the band with this coil, you may want to make other coils with more or fewer turns in order to increase the coverage of the set. The 1S4 pentode used as a detector requires 1½ volts for the filament, and will operate with a B battery that supplies anywhere from 4½ to 22½ volts. For best results use a good ground and antenna.—ALBERT ROWLEY.



The turns of the antenna coil have been bunched together to take as little space as possible. An antenna lead and 4-way battery cable are brought out from under the chassis.



For test purposes standard 1½ and 22½-volt batteries were used, but a penlight cell and a miniature B battery would provide a power supply hardly larger than the radio itself.

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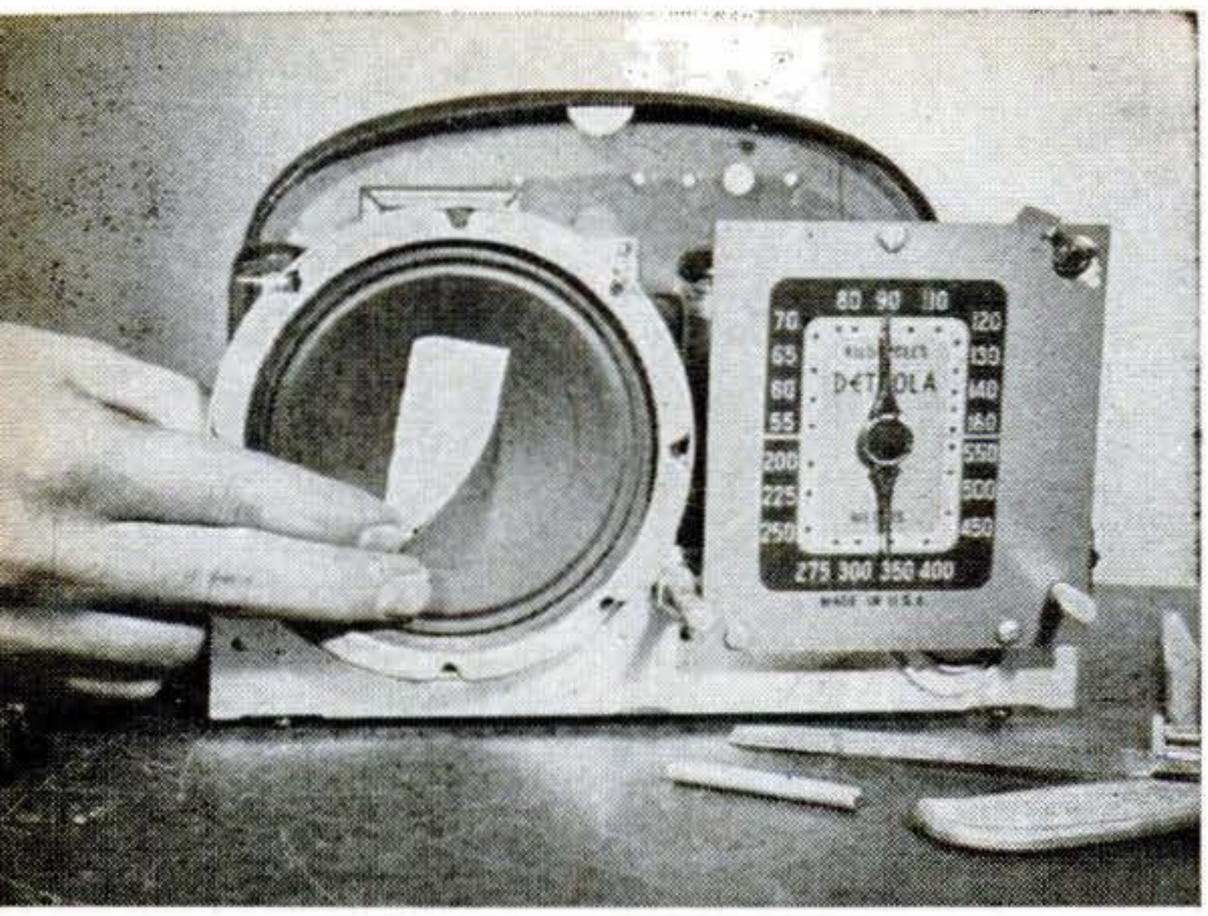
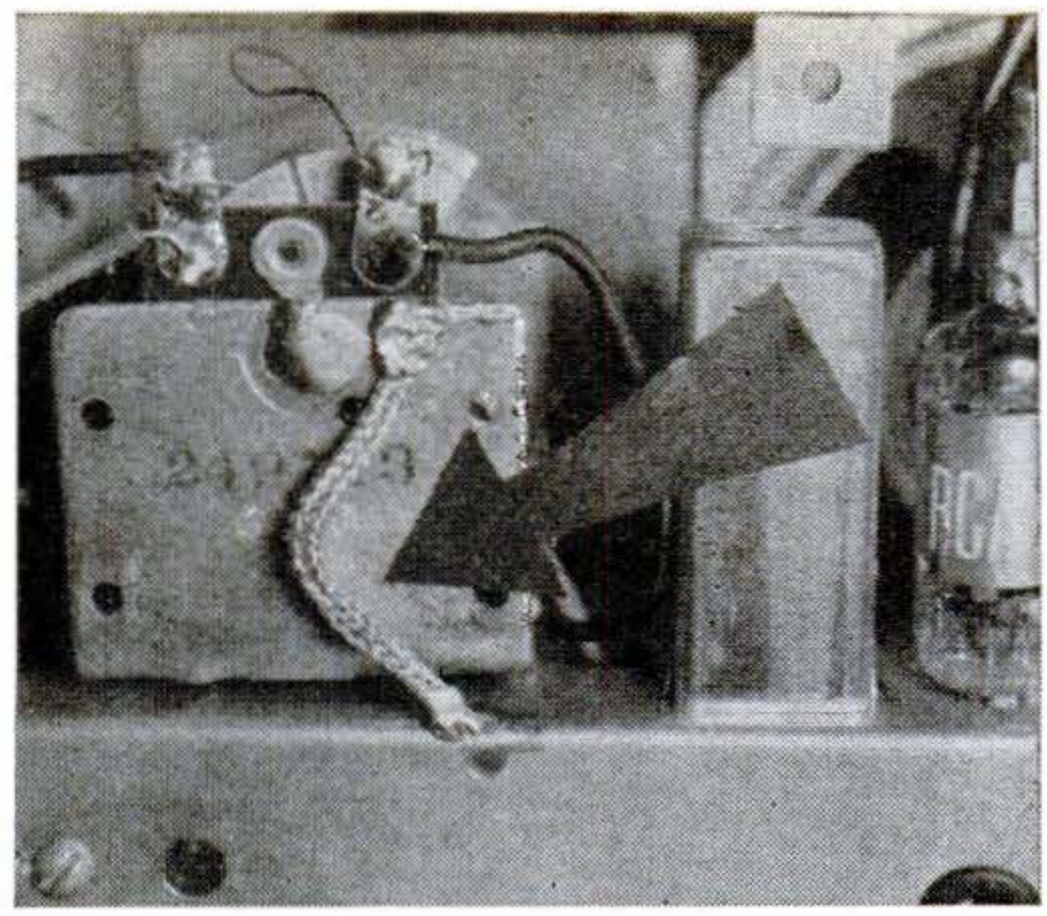


Tape Shields Speaker Magnet

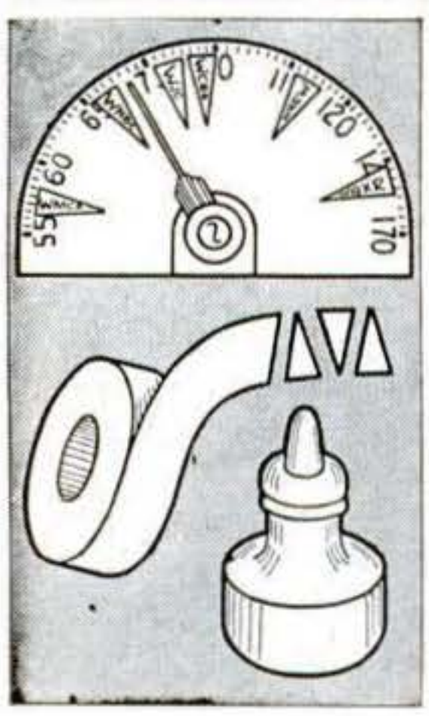
SHOULD you have to saw or file control shafts or other metal parts of a radio while making repairs or replacements, see that no filings are permitted to enter the speaker cone, where they may cause distortion and rattling. You can protect the speaker by keeping a strip of adhesive tape over the opening while you work.—H. LEEPER.



Braid Grounds Condenser

NOISY and erratic tuning is sometimes caused by a poor connection between a tuning-condenser rotor and ground. It is especially common in portables where the condenser has been mounted on rubber to absorb vibrations. A short piece of tinned braid soldered between the condenser frame and chassis cures it.—FRANK TOBIN.

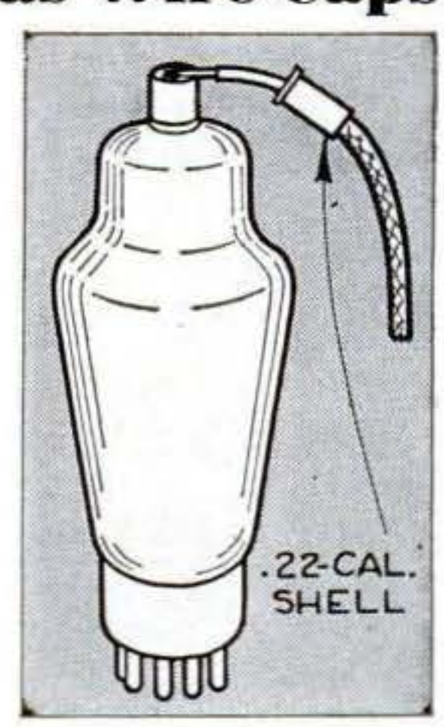
Markers Make Tuning Easier



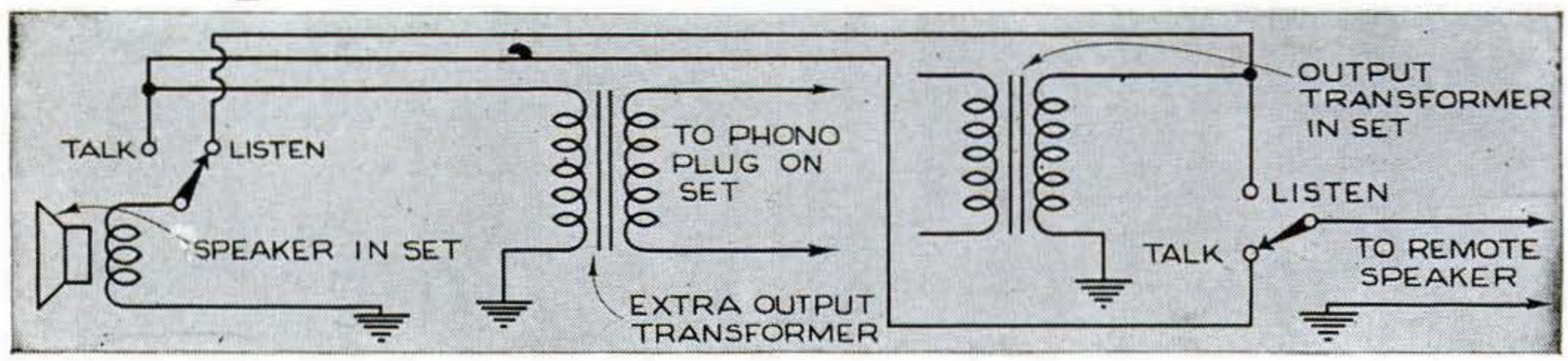
WEDGE-SHAPED bits of cellulose tape make station settings easy to locate. Lettered with India ink and placed in appropriate spots on the dial, they help you tune in where the light is poor without having to remember wavelengths of favorite stations.—G. E. HARRINGTON.

Rifle Shells Used as Wire Caps

NEAT ends for shielded wire can be made from used .22-cal. rifle shells. Drill or punch a hole in the end, slip the conductor through, and solder the braid inside the shell. Empty shells are also useful as grid caps. Spread or pinch the side of the shell to fit.—RICHARD SALZER.



Extra Speaker Converts Receiver to an Intercom



RADIO receivers having sufficiently high audio gain will double as intercoms with the addition of an extra speaker and transformer. A single wired connection to the remote speaker is sufficient, since the return can be made to a common ground. When the switches are turned to "Talk," the speakers act as microphones. A single DPDT switch may be substituted for the two SPDT units shown in the drawing.—LES JONES.

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Hitch Your Clock to the Stars

Timing a star transit takes little equipment. Be sure the tin isn't moved between evenings.

TIME is a major dimension of modern life, and nowadays our radios signal the passing of every hour. While these time signals are good enough for most purposes, an astronomer would be outraged by the inaccuracies that sometimes creep in. However, it's a simple matter to go directly to the central authority of all timekeeping—the stars—for aid in adjusting your timepiece so it will tick off the minutes with precision. All you need is a piece of tin about 1′ square and a couple of tacks.

A good wrist watch is adjustable to an accuracy of a minute or two a week. Pocket watches used by railroad men must be accurate within two minutes per month. An occasional "star-performer" among high-grade 17-jewel pocket watches will stay within one minute in six months, a variation of no more than ⅓ sec. per day. Of course, to keep good time, a watch must be handled carefully, protected from severe temperature change and violent physical motion. If you want to test and adjust the timekeeping behavior of your watch, timing a star transit is an enjoyable way of doing it.

First, take the sheet of tin and make a clean 1/16″ hole near the center. Tack the sheet securely to a firm support such as the side of your house, in such a way that you can peep through the hole at some distant vertical edge fairly high in the sky. The tower of a skyscraper will do if you live in the city. In the country, the lightning rod on the barn will serve admirably. Don't select a chimney, unless it's out of use, since its heat may make the adjacent air shimmer. If you're north of the equator, you should be sighting roughly toward the south.

Next, make friends with a particular star of good brightness that will pass behind the tower or lightning rod at a convenient time in the evening. Make a note of the exact time, by your watch, when this star disappears behind the obstruction. If you have picked something with a clean vertical edge, the star will be occluded almost instantaneously because it is, for all practical purposes, a point of light and not a disk. If it fades gradually, you're probably looking at a planet, which does have an appreciable disk.

Be out at your star-gazing post about five minutes earlier the next evening and you will see the same star occluded exactly one sidereal day later, i.e., 23 hours, 56 min., 4.09 sec. after the previous night's occlusion. In other words, a given star will pass through the same vertical line exactly 3 min., 55.91 sec. earlier each night. If you have an assistant calling out each second as indicated by the watch while you observe the transit, you can check the performance of your timepiece. Then, if it's off by more seconds than you care to tolerate, you have merely to advance or retard the hairspring adjusting lever and test it again. It's a good idea to observe the occlusion of three or four stars in one constellation so that you can cross-check on both yourself and your assistant.

Men prefer to live by solar time, but the sun is a notoriously poor timekeeper, sometimes making its daily trip in more than 24 hours and sometimes less. Consequently, we use a fiction called "mean solar time", arrived at with the aid of a purely imaginary Old Sol that behaves much better than the one we have. So don't make the mistake of trying to regulate your watch with a sundial. Look to the stars!—GILBERT SONBERGH.

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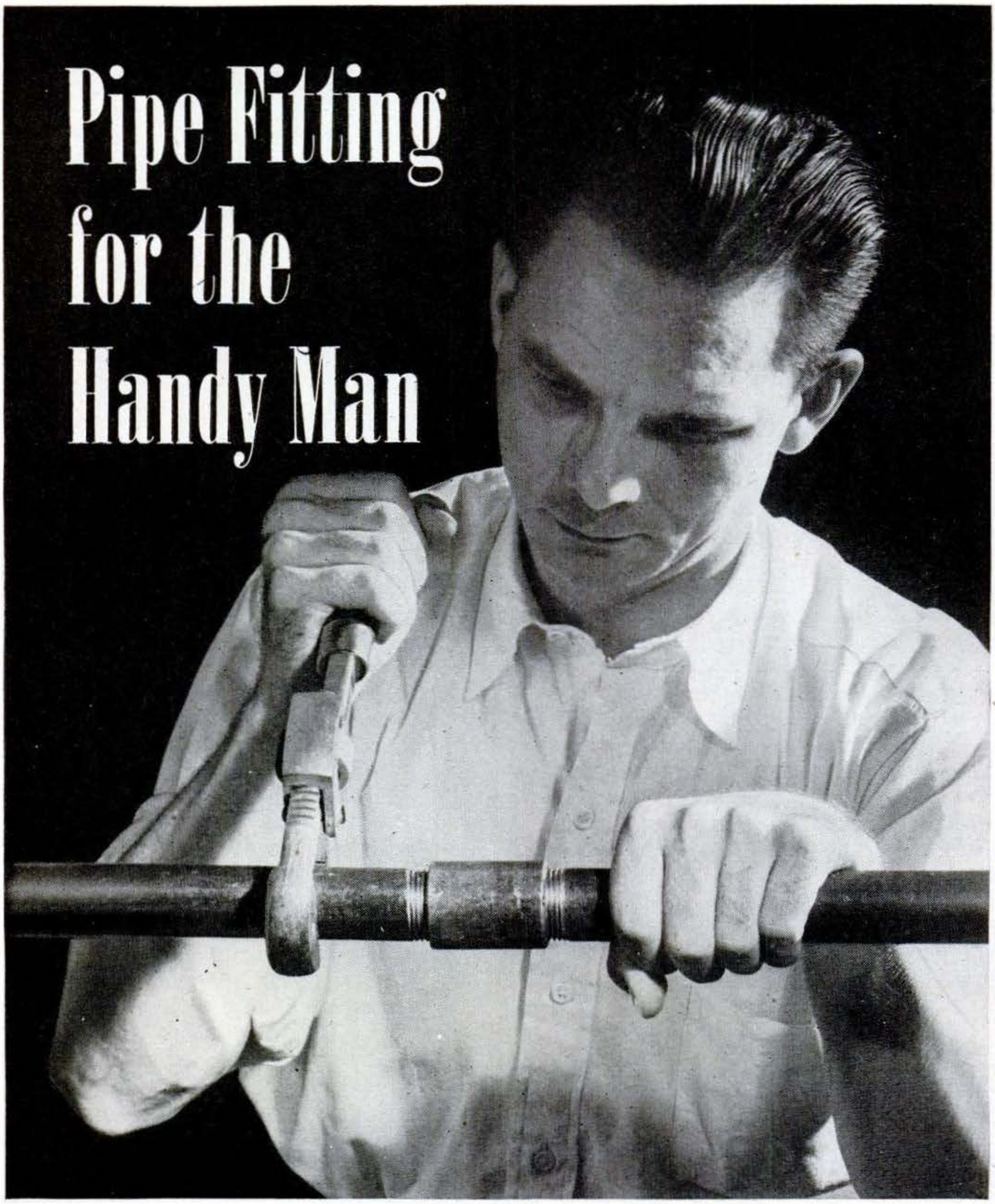
Pipe Fitting for the Handy Man



By W. C. Hughes

MOVING the kitchen stove to a new location or putting in an extra hot-water outlet near the washing machine is a job full of pitfalls for the inexperienced. Yet there is nothing hard about it when a few facts about pipe fitting are understood. The handy man who will learn the rules of the game can do a good job on his first try.

What tools are needed? At least two pipe wrenches, preferably the 18″ size, will be your mainstays. A 6′ folding rule and a steel square, such as a carpenter's square, are necessary. Very useful is a combination square with protractor for laying out angles and offsets. A big monkey wrench is needed for unions.

This is a minimum list, and assumes you will buy pipe cut and threaded to your specifications, which you can do at most large plumbing supply shops. If you work

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at a distance from such sources or want to be independent of them, you'll need a hacksaw or pipe cutter and pipe-threading dies. I suggest you buy a pipe cutter with three cutting wheels. The single-wheel type must be rotated a full 360 deg., which is sometimes impossible without removing the pipe. A hacksaw will cut without leaving as large a burr as a cutter will, but demands more care to insure a perfectly square cut and is hard to use in a tight spot. Plumbers use a reamer to remove the burr, but you can manage with a rattail file if you don't plan to do a great deal of work.

Pipe dies and a stock to hold them are costly, but it pays to buy good ones. You should find a set comprising the ½″, ¾″, 1″, 1¼″, and 1½″ sizes ample for your needs. For threading, pipe is best held in a pipe vise. Perhaps your workbench vise has teeth below the jaws for gripping pipe.

A lot of confusion is caused the beginner by pipe sizes. For instance, ⅛″ pipe measures roughly ⅜″ o.d., and other sizes carry on the discrepancy. Sizes are based on the hole in the pipe, but even so are nominal, rounded to a common fraction for convenience. Thus ⅛″ pipe measures about 17/64″ i.d., considerably more than its nominal size. Larger pipe comes closer, 1″ pipe having an inside diameter only a trifle (about 3/64″) bigger than its nominal size.

There are three classes of pipe: standard, extra strong, and double extra strong. These classes refer to wall thickness. Since the outside diameter must be the same to thread into standard fittings, extra wall thickness is gained by decreasing the inside diameter (Fig. 1). Thus 1″ standard pipe is 1.315″ o.d., 1.049″ i.d. But extra strong pipe, although measuring the same outside diameter as standard, is only .957″ i.d.; double extra strong 1″ pipe is only .599″ i.d. It's the nominal size the pipe fitter uses for fitting calculations—1″ for 1″ pipe, and so on.

Pipe threads are fairly coarse, gaining tightness against leaks largely by being tapered—that is, smaller on the end of the pipe and gradually becoming larger, so providing a strong wedging action. The standard thread taper is 1/16″ per inch, or ¾″ per foot.

Screwed joints make use of fittings, the most common ones being shown on page 212. The letters designate the dimensions shown by the arrows. These vary, of course, with the size of the fitting. The boxed information given will prove handy not only

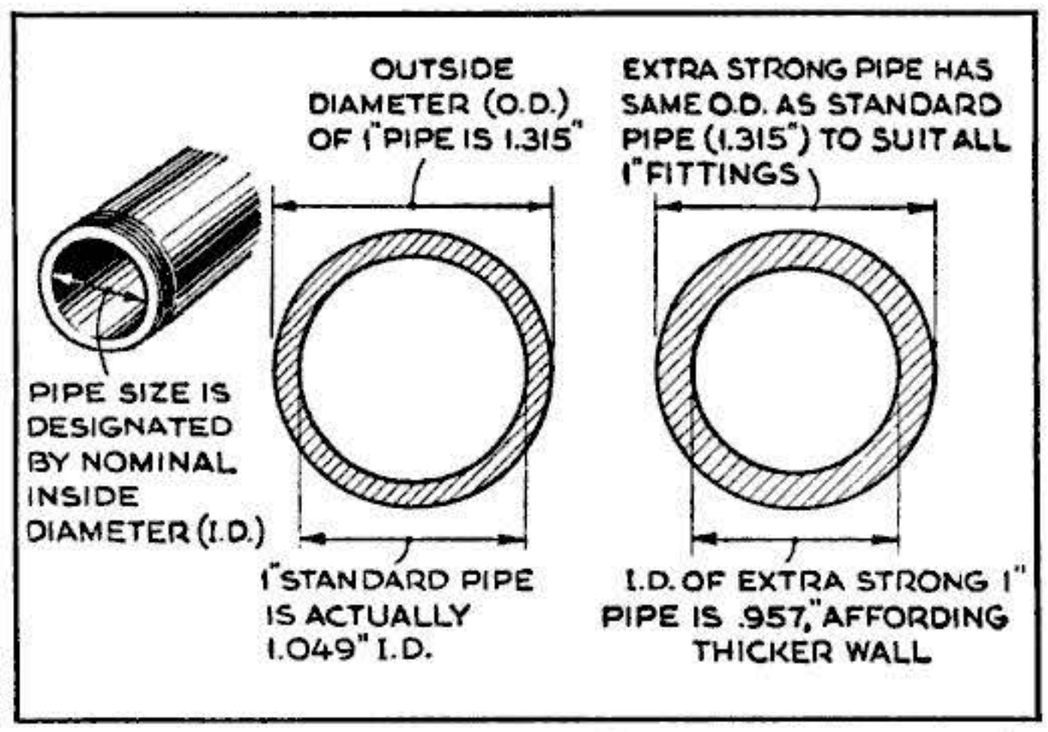

Fig. 1. How pipe is sized. Extra wall thickness is gained by sacrificing inside diameter.

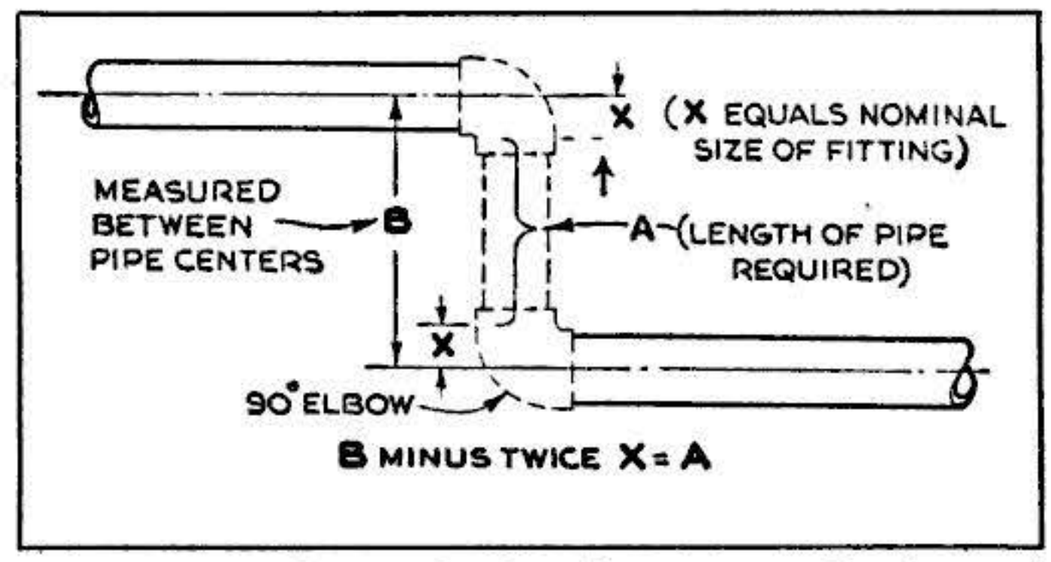

Fig. 2. Right-angle bends are easily figured as above or by using elbow data on page 212.

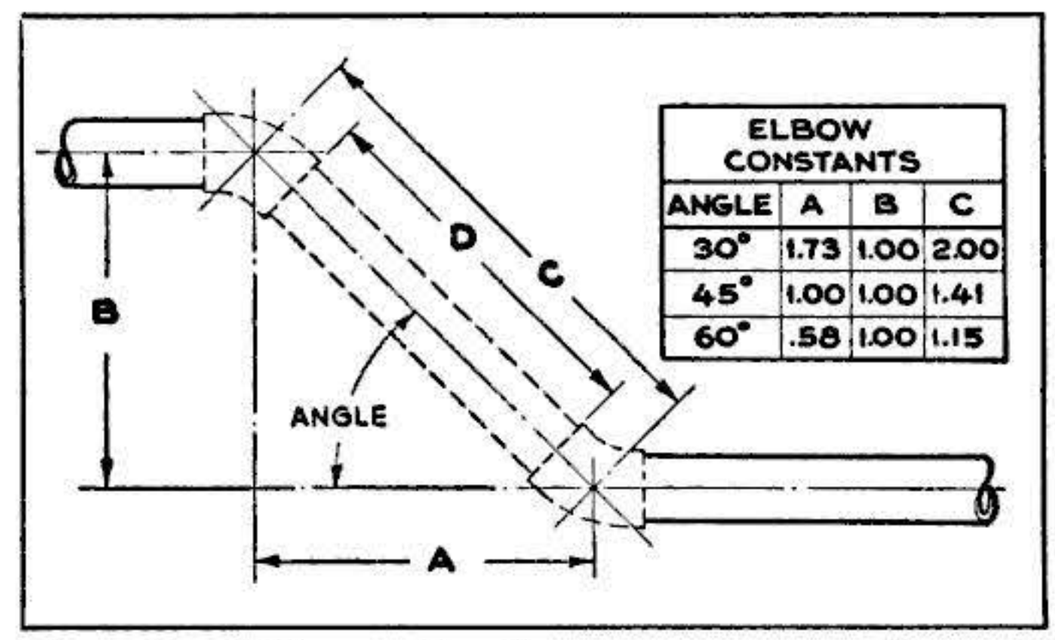

Fig. 3. Offsets of other common angles call for a simple calculation to determine run C.

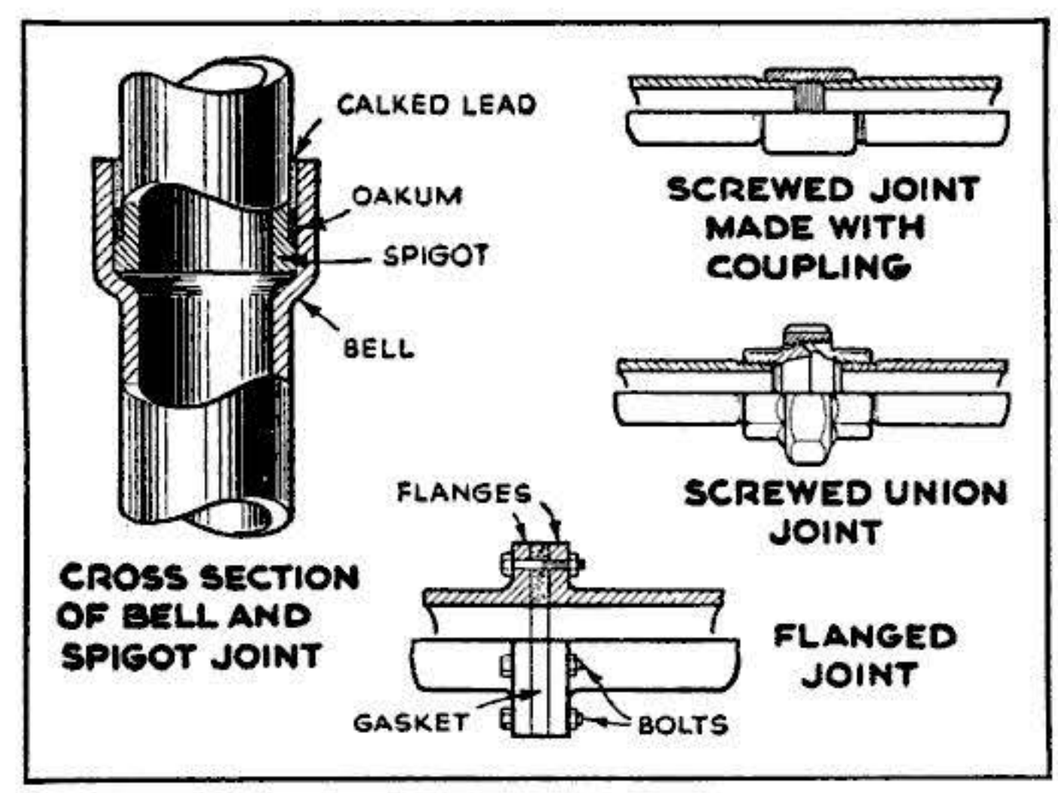

Fig. 4. Four common pipe joints. Flanges and unions should be carefully aligned and clean.

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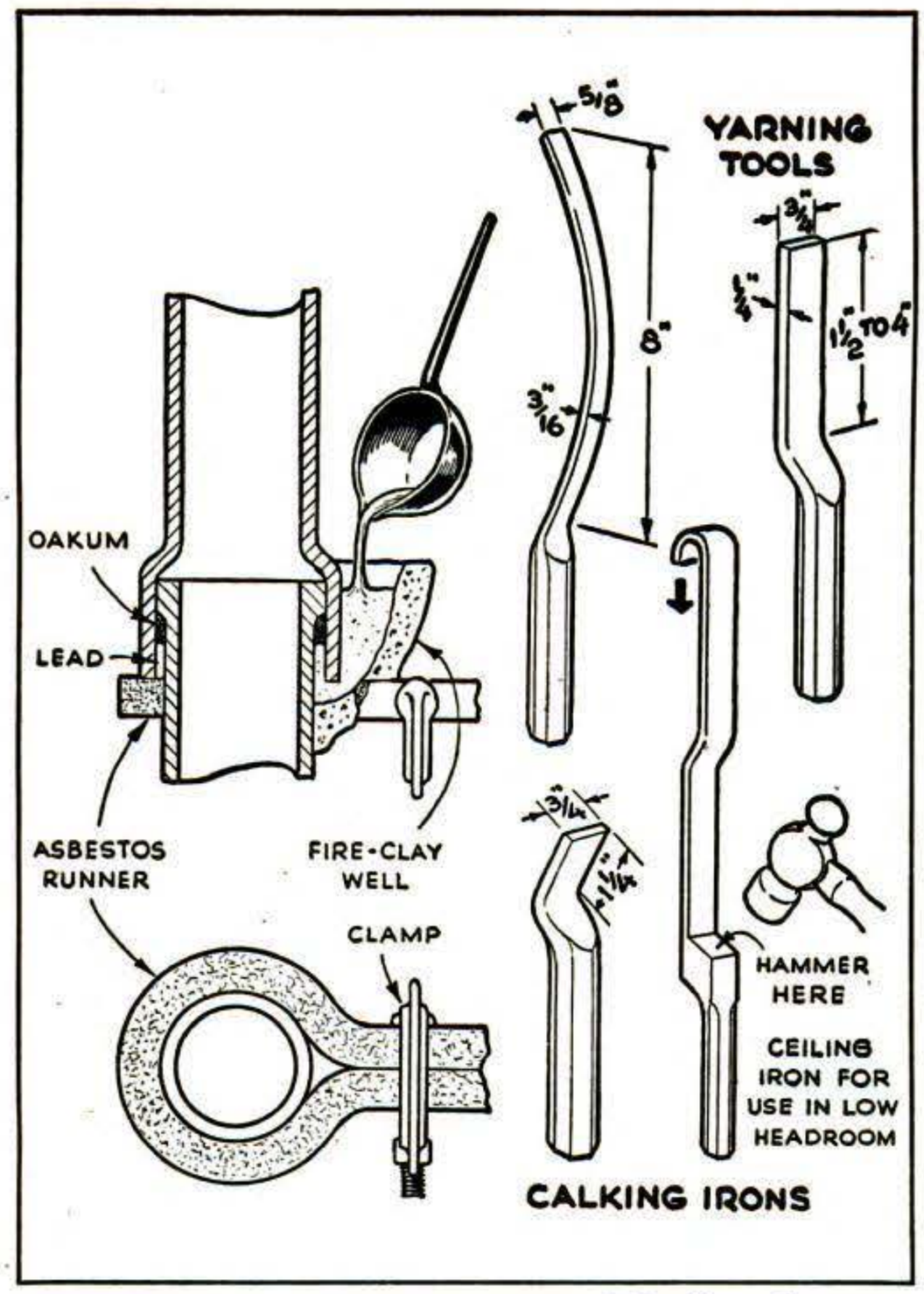


Fig. 5. How to pour inverted bell-and-spigot joints, and some of the special tools needed.

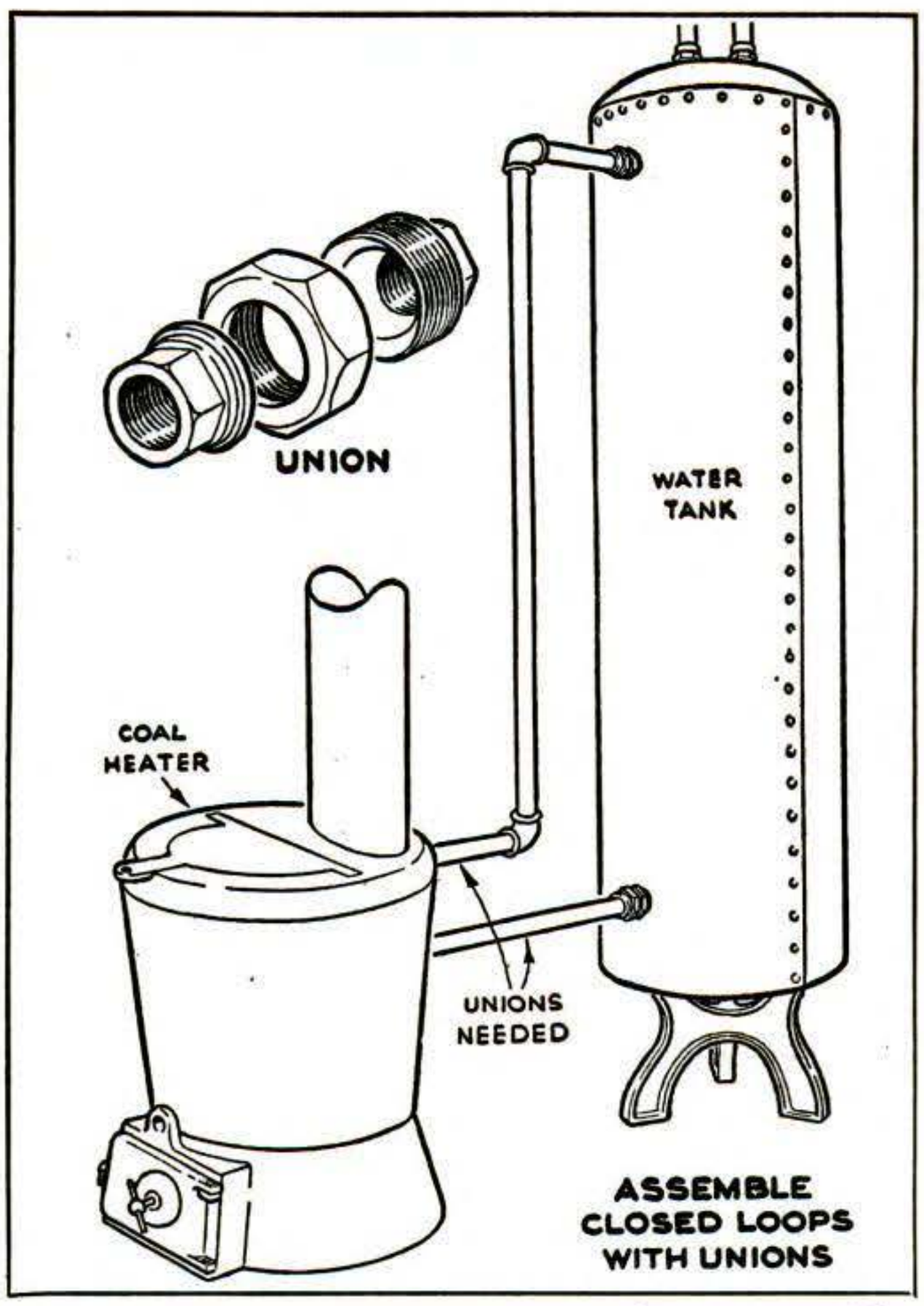
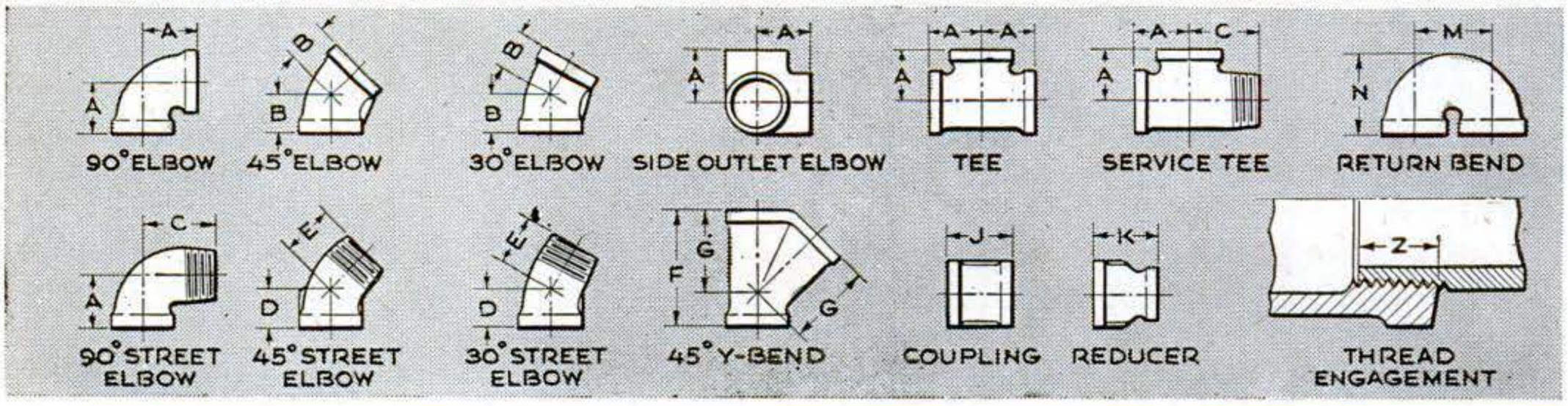


Fig. 6. Unions are necessary for setups like this. Put the nut on the pipe before assembly.



PIPE FITTINGS

[HANDY MAN]

Size	A	B	C	D	E	F	G	J	K	Z
1/8	11/16	1/2	1	11/16	13/16			15/16		1/4
1/4	13/16	3/4	1 3/16	5/8	15/16			1 1/16	1	3/8
3/8	15/16	13/16	1 7/16	11/16	1 1/16	2 1/8	1 7/16	1 3/16	1 1/8	3/8
1/2	1 1/8	7/8	1 5/8	13/16	1 3/16	2 7/16	1 11/16	1 5/16	1 1/4	1/2
3/4	1 5/16	1	1 7/8	15/16	1 5/16	2 13/16	2 1/16	1 1/2	1 7/16	9/16
1	1 1/2	1 1/8	2 1/8	1 1/16	1 1/2	3 3/8	2 7/16	1 11/16	1 11/16	11/16
1 1/4	1 3/4	1 5/16	2 7/16	1 1/4	1 11/16	4 1/16	2 15/16	1 15/16	2 1/16	11/16
1 1/2	1 15/16	1 7/16	2 11/16	1 3/8	1 7/8	4 1/2	3 5/16	2 1/8	2 5/16	11/16
2	2 1/4	1 11/16	3 1/4	1 11/16	2 1/4	5 7/16	4	2 1/2	2 13/16	3/4
2 1/2	2 11/16	1 15/16	3 13/16	1 7/8	2 9/16	6 1/4	4 11/16	2 7/8	3 1/4	15/16
3	3 1/8	2 3/16	4 1/2	2 1/8	3	7 1/4	5 9/16	3 3/16	3 11/16	1

Return Bends

Close Pattern

Size	M	N
1/2	1	1 3/4
3/4	1 1/4	2 3/16
1	1 1/2	2 1/2
1 1/4	1 3/4	2 13/16
1 1/2	2 3/16	3 3/16
2	2 5/8	3 7/8

Open Pattern

Size	M	N
1/2	1 1/2	1 7/8
3/4	2	2 1/4
1	2 1/2	2 5/8
1 1/4	3	3 3/16
1 1/2	3 1/2	3 5/8
2	4	4 3/8

POPULAR SCIENCE MONTHLY SHOP DATA

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for ordinary pipe fitting, but in using pipe for other purposes such as railings, supports, and so on.

Once you've spotted your gas stove or decided just where the new outlet is to go, it's important to make correct measurements. The plumber can eventually find a place on another job to use a wrongly cut piece of pipe, but the home pipe fitter can only save it in the hope that some day he'll find a use for it. Meanwhile, he's out of pocket the price of a new piece.

Measurements are made from center to center of the lengths to be connected. In Fig. 2, to decide how long the short length of pipe should be to connect the horizontal legs, we first measure between pipe centers to get the dimension B. Since the elbows will take up some space between the legs, this must be deducted from B.

A quick, fairly reliable rule of thumb for 90-deg. bends, valid up to the 1¼″ size, is this: the fitting will take up as much space as its size. Thus if B measures 12″ and we are using ½″ pipe, each elbow will take up ½″ and the connecting pipe A should be cut 12″ minus twice ½″, or 11″ long. To be more precise, you can use the data on page 212. Here the center-to-flange length of each elbow is given as 1⅛″. Therefore the distance between elbow flanges would be 12″ minus twice 1⅛″, or 9¾″. But to this we must add enough for the threaded ends of the pipe to enter the elbows. Thread engagement (shown as Z on the table) for ½″ pipe is ½″, so twice this is added to 9¾″, giving 10¾″. We see that our rule of thumb gave us a safe approximation, close enough for practical purposes.

Where connections are to be made at an angle other than 90 deg. (Fig. 3), having again determined the distance B between pipe centers, you need to know the length of the piece connecting the two elbows. For this the distance C must be known. To find it, regardless of the size of pipe used, you employ certain figures known as elbow constants. These, shown in the small box in Fig. 3, tell how long C will be compared to B if the elbows are 30, 45 or 60 deg. Since B is a known dimension, it is listed as 1.00. If you are using 30-deg. elbows, C will be 2.00, or twice whatever B measures. With 45-deg. elbows, C will be 1.41 times B, and for a 60-deg. connection, 1.15 times B.

Having found C, the distance between the centers of the ends of the pipes, you must deduct the space the elbows will occupy, as found on page 212. Remember to deduct twice the figure given, as there are two elbows. This gives D, the distance between them. Then add double the thread engagement given as Z in the table, and you have the length of pipe needed.

Where other fittings are used, calculate the pipe length similarly after getting the fitting dimensions from the table. When you use reducing fittings to change from one size of pipe to another, the side of the fitting you are working with is the only one

PIPE SIZES

[HANDY MAN]

STANDARD PIPE				EXTRA STRONG PIPE		
Nominal Size	Diameters External	Diameters Internal	Threads per Inch	Nominal Size	Diameters External	Diameters Internal
⅛	0.405	0.269	27	⅛	0.405	0.215
¼	0.540	0.364	18	¼	0.540	0.302
⅜	0.675	0.493	18	⅜	0.675	0.423
½	0.840	0.622	14	½	0.840	0.546
¾	1.050	0.824	14	¾	1.050	0.742
1	1.315	1.049	11½	1	1.315	0.957
1¼	1.660	1.380	11½	1¼	1.660	1.278
1½	1.900	1.610	11½	1½	1.900	1.500
2	2.375	2.067	11½	2	2.375	1.939
2½	2.875	2.469	8	2½	2.875	2.323
3	3.500	3.068	8	3	3.500	2.900

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to consider. For instance, if you are connecting the ½″ side of a ½″ by ¾″ reducing elbow, take the dimensions from the ½″ line on the table.

After cutting pipe to length, be sure to ream or file out any rough edge inside. Clamp the piece in a vise or otherwise hold it firmly, fit the proper die in the stock, and start it on the pipe—clockwise, of course. As soon as the die begins to cut, lubricate the chasers with lard oil, bacon drippings, or any good cutting oil. Then continue threading, *slowly*. Lack of lubricant or rushing the work will heat the pipe, expanding it so that the die cuts too deeply and makes a poor thread. Blow out the chips every two or three turns, keep adding lubricant, and be careful not to cut too long a thread. With most dies, the correct length is cut when the pipe is just through the die and flush with the chasers. When the thread is cut, back off the die slowly and brush any chips off the thread with an old toothbrush. Don't spin the die off; it may jump the tapered thread and ruin it.

Now you are ready for assembling, or "making up" the joint. See that the threads inside the fitting as well as those on the pipe are clean. Put a little white lead or commercial pipe compound (nonhardening "dope" facilitates taking pipe apart later if necessary) on the pipe threads. Never put any on internal threads, as in fittings.

Screw the parts together by hand as far as they will go; then continue with the pipe wrench. Again it's important to take your time. Hurrying will heat the metal, expanding it and resulting in a leaky joint. Don't make the common mistake of thinking that the tighter you turn it, the better the joint. A well-made joint will always have one or two threads showing *outside* the fitting after it has been turned in snugly.

Bending pipe will enable you to dispense with some fittings and a good deal of cutting and threading. Remember that the smallest radius is five times nominal pipe size. Bend pipe around a large pipe, column, or other solid object of suitable diameter. It's best to pack the pipe full of dry sand and cap both ends; with brass or copper pipe this is almost a "must." I find it a good idea, when bending pipe, first either to bend a duplicate of the required piece from stiff wire, or to lay out a full-size drawing, the wire or drawing representing the centerline of the bent pipe.

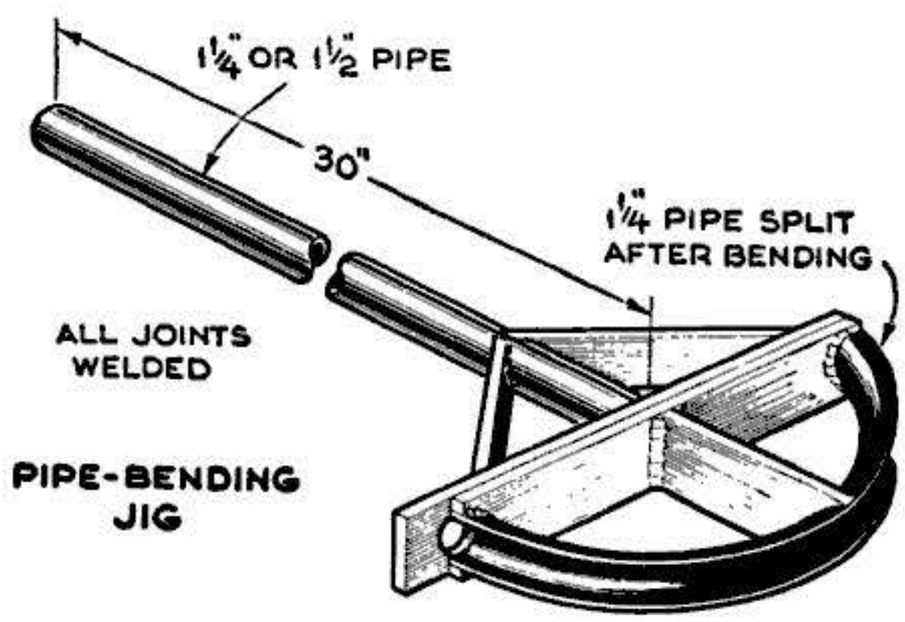
Soil pipe, usually of cast iron, is assembled with bell-and-spigot joints. Cast-iron pipe is cut with a cold chisel, a light cut being made all around and gradually deepened until the pipe is cut through.

Making the joint calls for careful work. After fitting the spigot into the bell as shown in Fig. 4, pack the space between with oakum, using a yarning iron or similar tool (Fig. 5). Build up the packing slowly, making sure it is solidly compressed all around, until the bell is at least half full.

Before pouring the joint, be sure that it is bone dry. Water and hot lead don't mix; even a drop or two of water can bring about disaster, as pocketed steam will explode violently, hurling hot lead everywhere. Pour in molten lead, and as soon as it begins to set, calk it with a calking iron (Fig. 5). Use light blows so as not to cut the lead to bits.

If the bell is upside down or the joint a horizontal one, a "joint runner" of asbestos must be used together with a fire-clay dam or well higher than the oakum in the bell, as shown in Fig. 5. Such joints aren't easy to make, and if at all possible you should avoid them until you have made the common kind shown in Fig. 4 successfully.

Jig for Bending Pipe



One 30″ length of 1¼″ pipe forms the lever of this jig. The bending head is a piece of similar pipe bent to a semicircle 12½″ in diameter. This is then split all along the curve (preferably with an oxyacetylene cutting torch) and the rough edges filed or ground clean. A piece of ¼″ thick iron with a 1⅜″ hole at one end is welded across, the handle welded to this, and reinforcing braces added as shown. The device will handle any pipe up to 1″.

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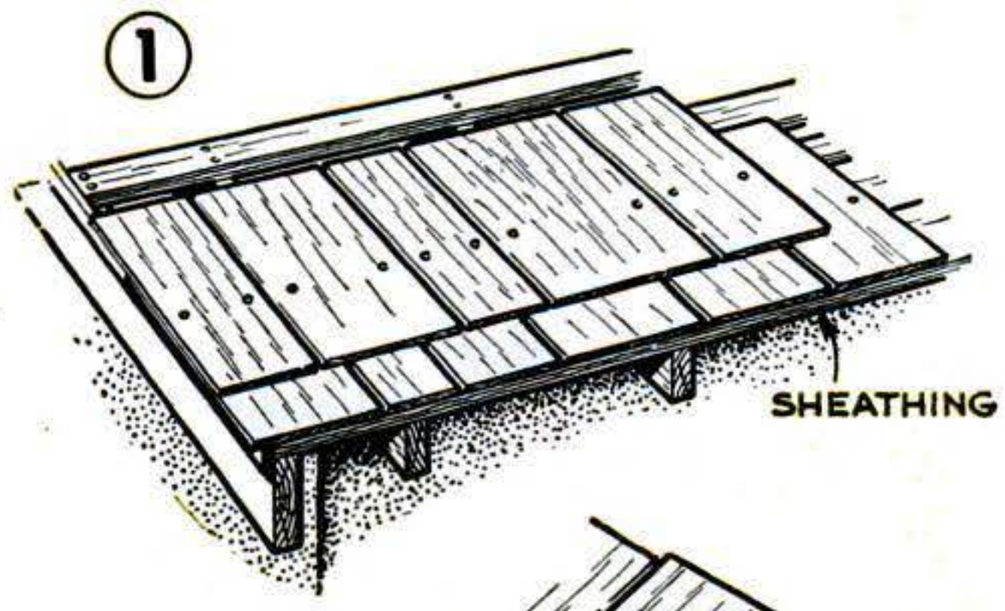
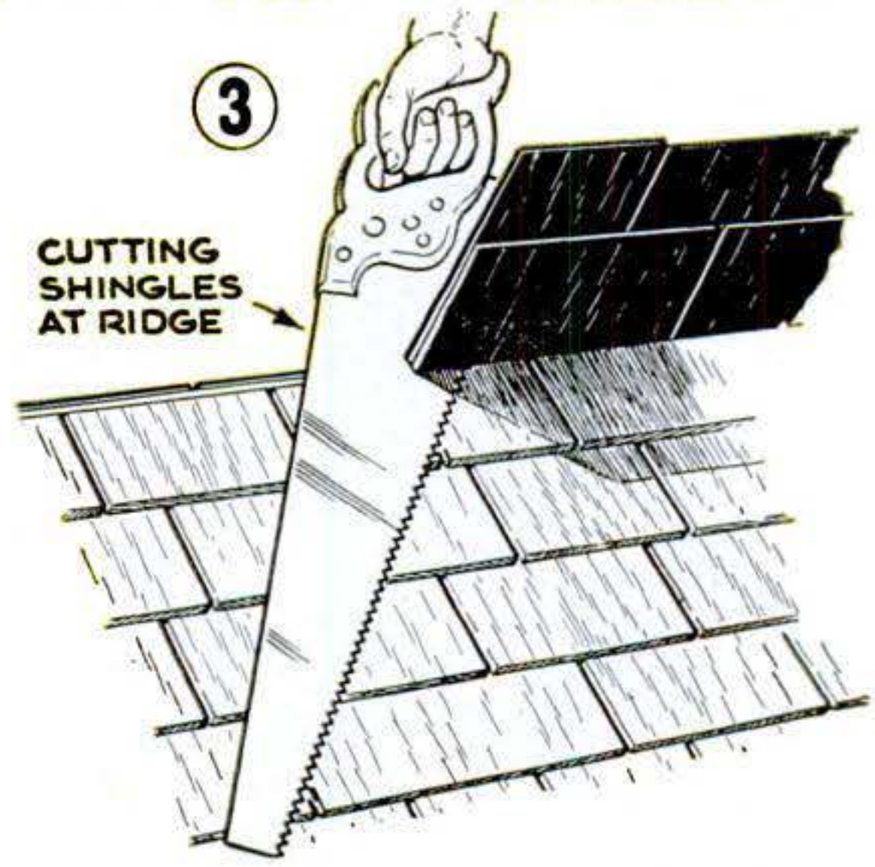
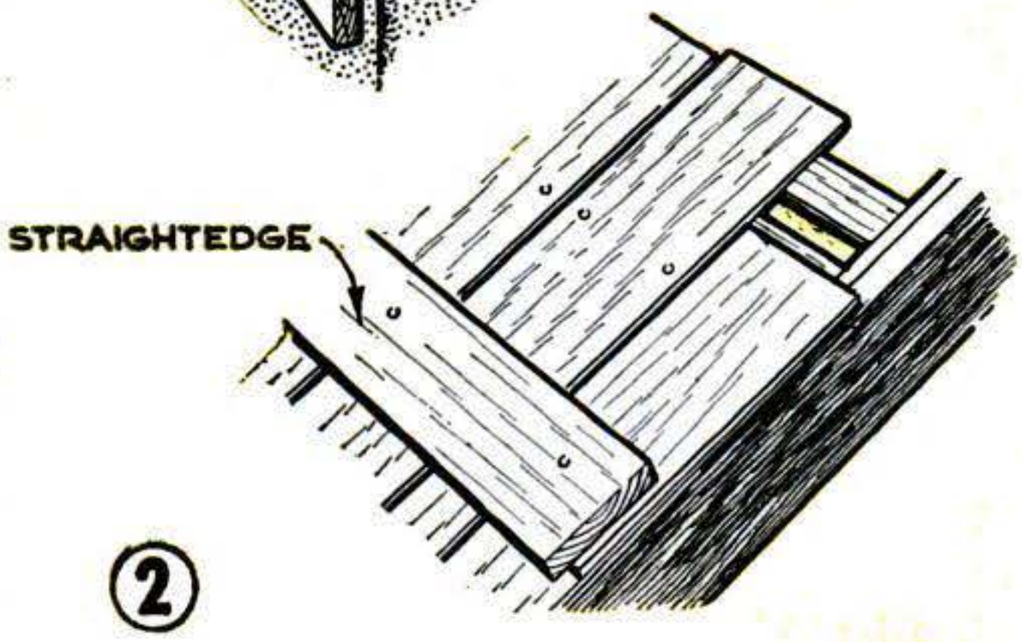
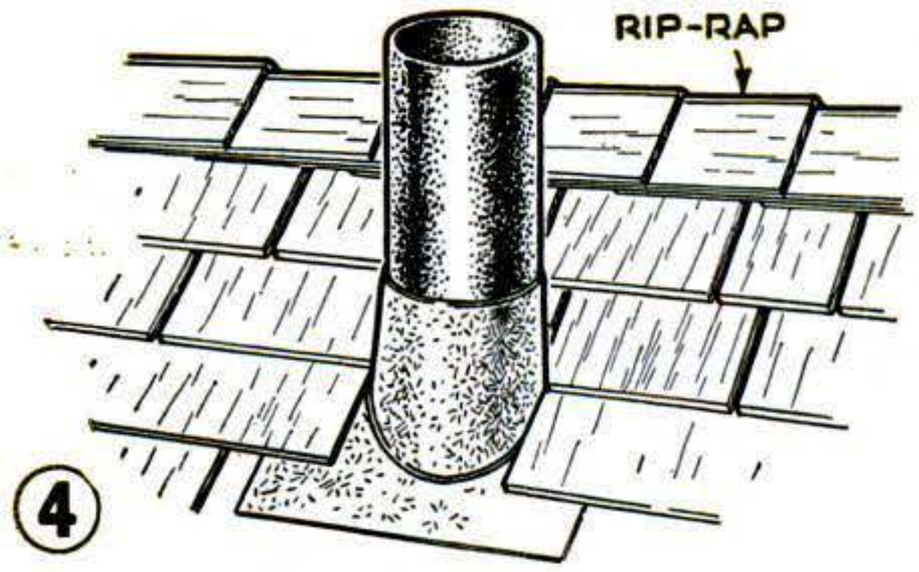
WHAT'S WRONG ?









SEVEN roofing errors are shown in the drawings, two each in Nos. 1, 3, and 4. One in No. 3 is a little tricky, but you will get it if you look carefully.

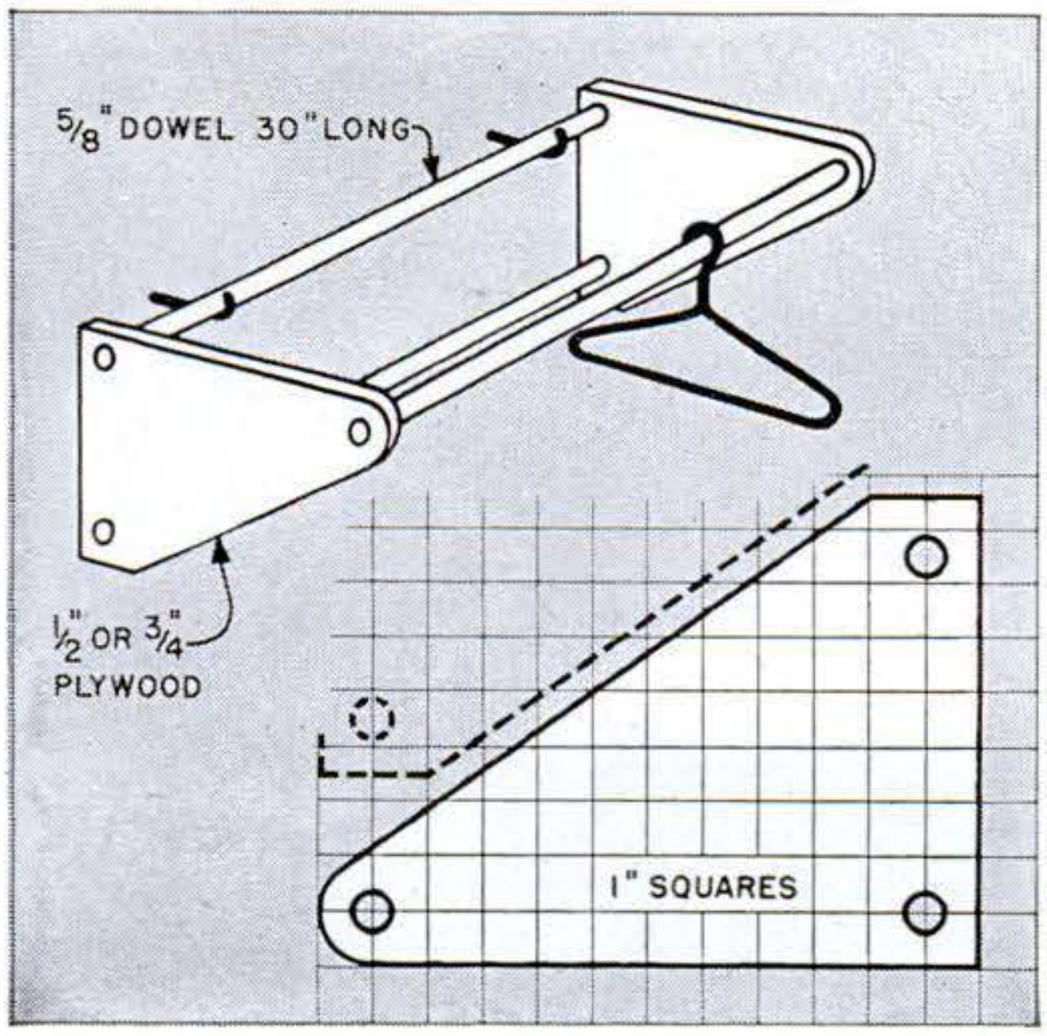
Answers: 1. The starting shingle course should project about 1¼" beyond the sheathing, and it should be a double course with covered joints. Either error allows rain to soak into the sheathing.

2. A straightedge used to align the shingle course being laid should be narrow enough to expose the butts of the course beneath so joints can be seen.

3. Roofers prefer to cut off the tips of shingles with the corner of a hatchet. Note also that the joints of alternate shingle courses come over each other. Joints should be offset about 1½" to avoid three in a line if the shingle between splits at the joint.

4. At least 1" space should be left between shingles and the vent-flashing sleeve to permit dirt to wash away. Rip-rap shingles should overlap alternately from both sides of the ridge.

Clothes Rack Hangs on Wall



WHERE closet space is lacking in a home, garage, or shop, a rack for holding suits on hangers can easily be supported by hooks in the wall. Cut two plywood or solid ends to the pattern shown, and drill them slightly undersize for a press fit for three lengths of 1" dowel. If the fit is tight, glue will not be needed in the assembly.

Short lengths of ¼" dowel may be similarly pressed into undersize holes in one or both endpieces. They make convenient racks for neckties or shop aprons.

Sand the work smooth and finish to suit. The piece may be painted to match the color scheme of the room, or it may be given several coats of shellac.—RICHARD HANSCOM.

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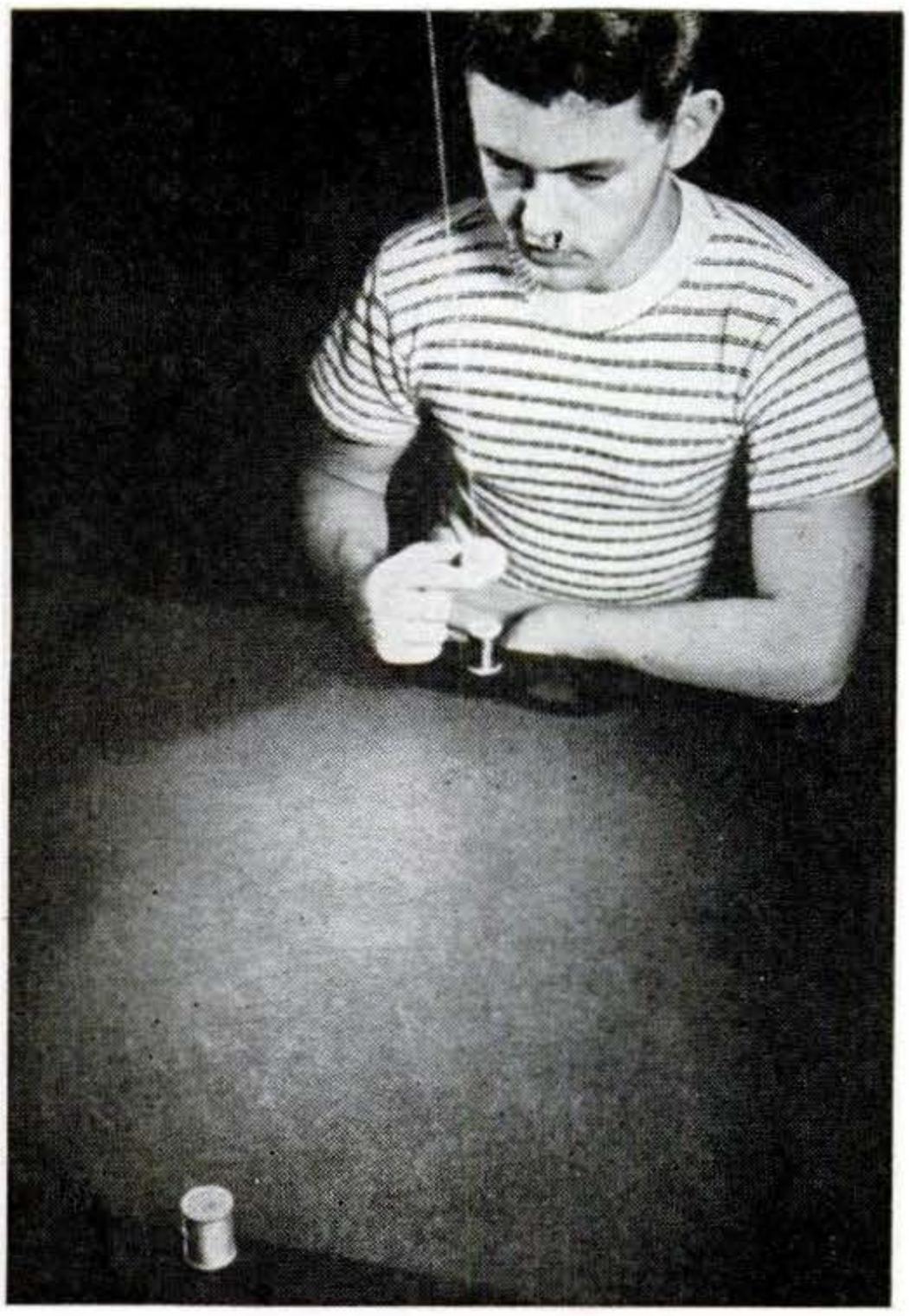

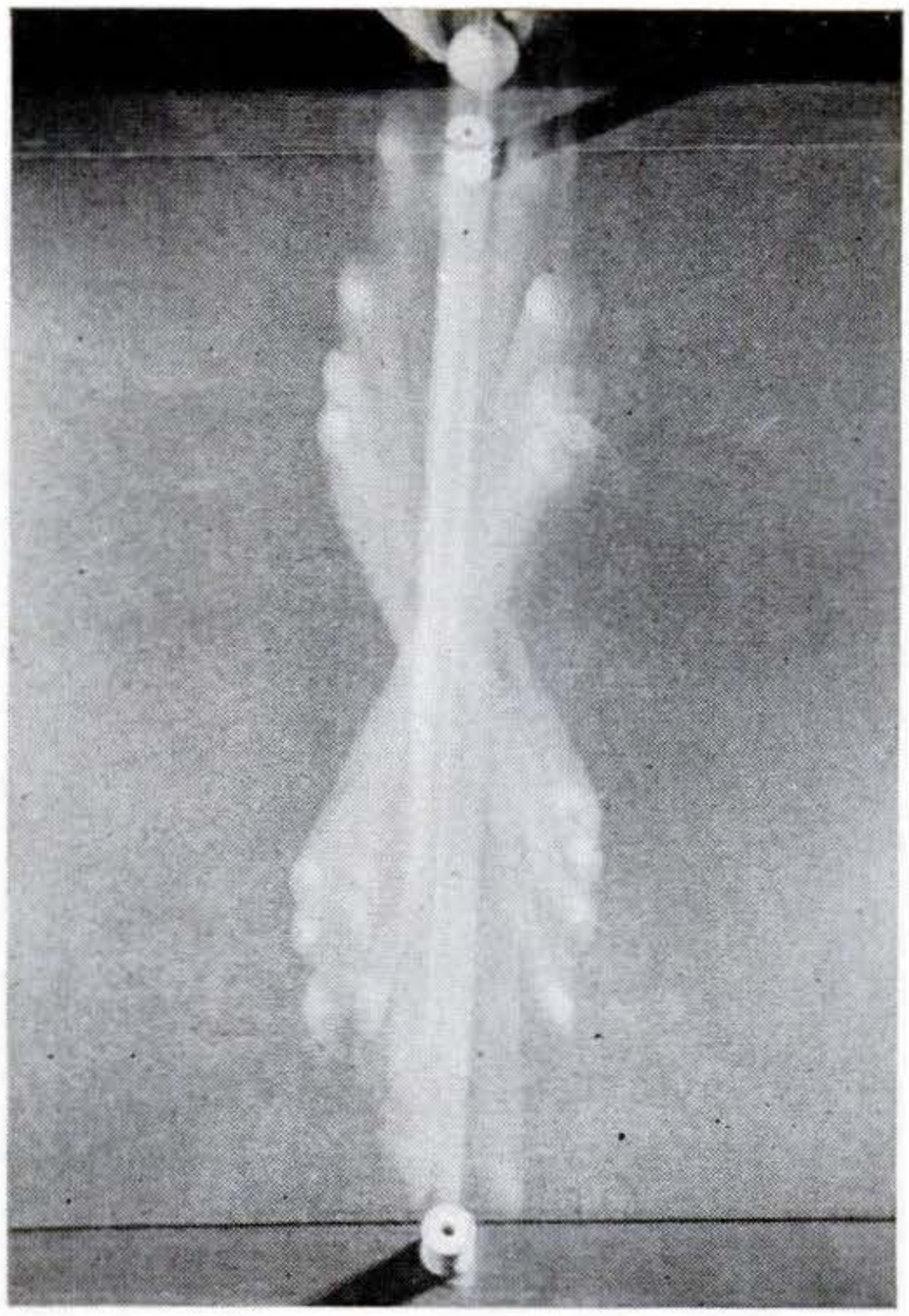

Why a Spinning Ball Curves

Air Pressure Does It. Daniel Bernoulli, an 18th Century Swiss mathematician, observed that the internal pressure of a fluid—such as air or water—decreases as the velocity of the fluid increases. To test this strange effect, suspend a table-tennis ball from a string about a yard long. Draw the ball back and let it go. It swings straight back and forth. Now twist the string about 50 turns. As the ball spins it carries air around with it. This increases the velocity of the air stream passing the ball on one side. The ball will curve toward the side of the faster moving air because the greater pressure on the other side pushes it over.

HOME EXPERIMENTS

Rotors Offset Wind. A coffee can and an electric fan show in miniature how the famous rotor ships were able to keep their course regardless of wind direction. Suspend the can at four points, twist the string well, and then let go. When the can is spinning rapidly turn on a fan about a foot away. The can will move in the direction of the side that is going the same way as the breeze.

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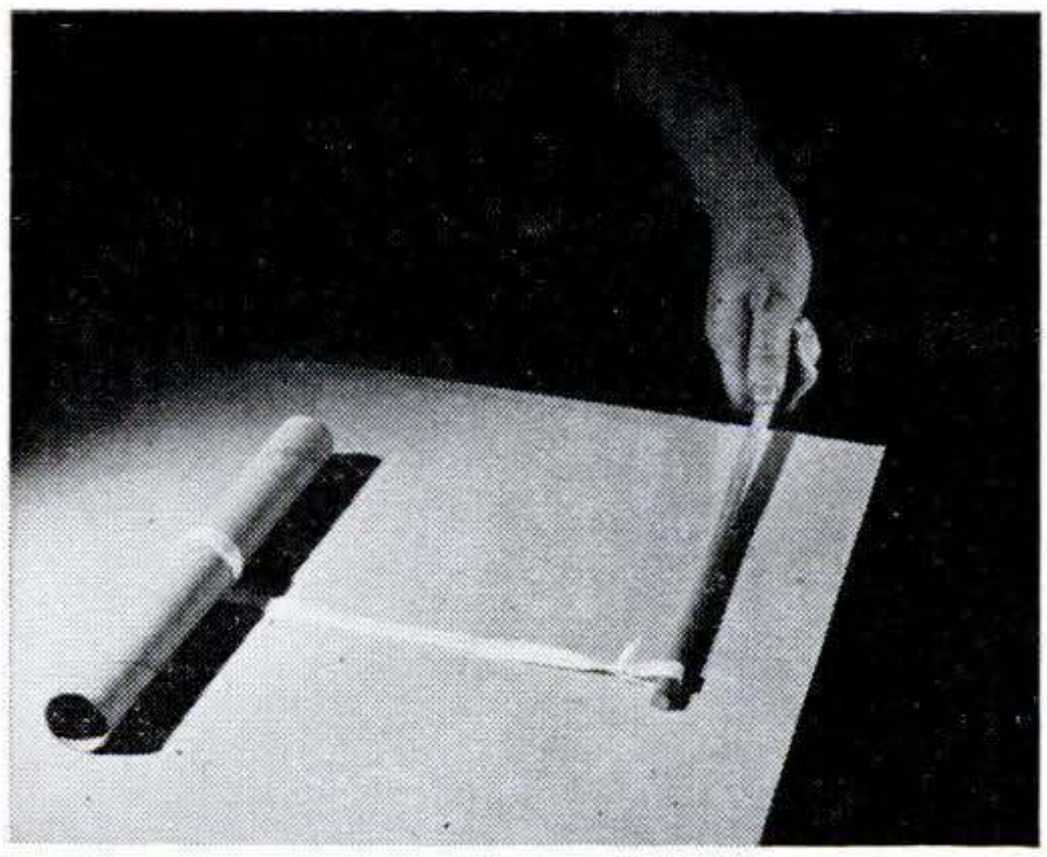
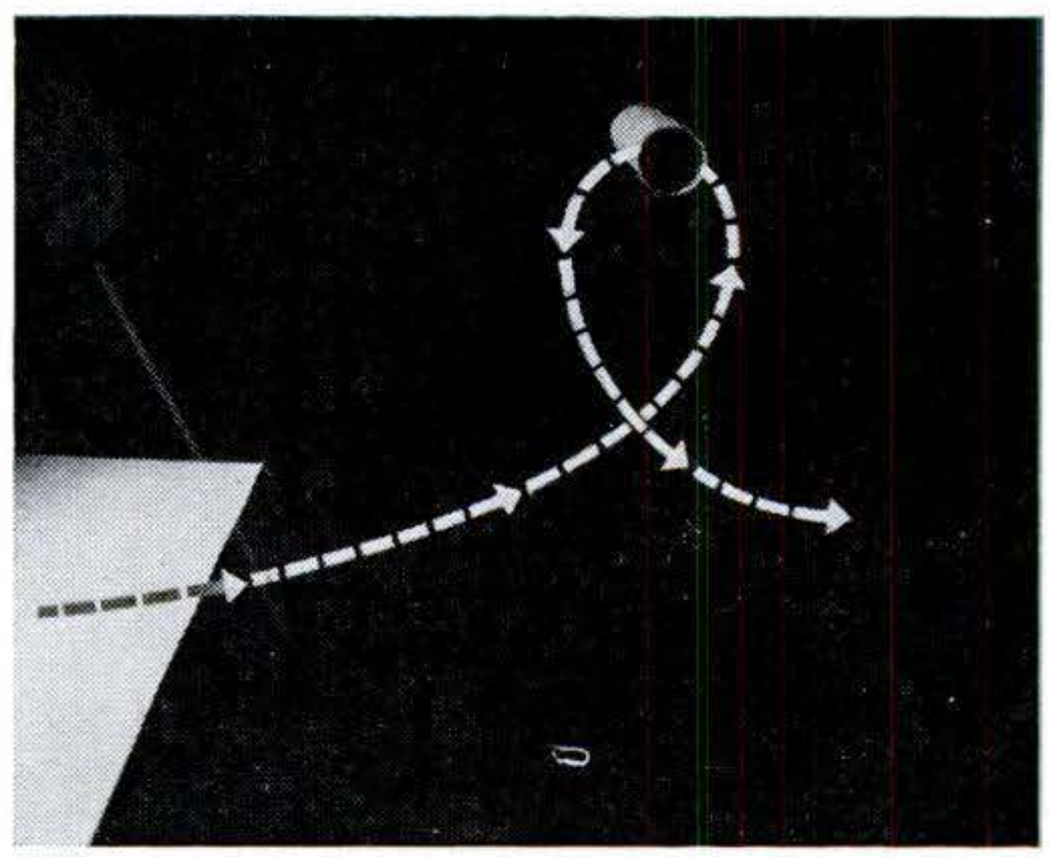
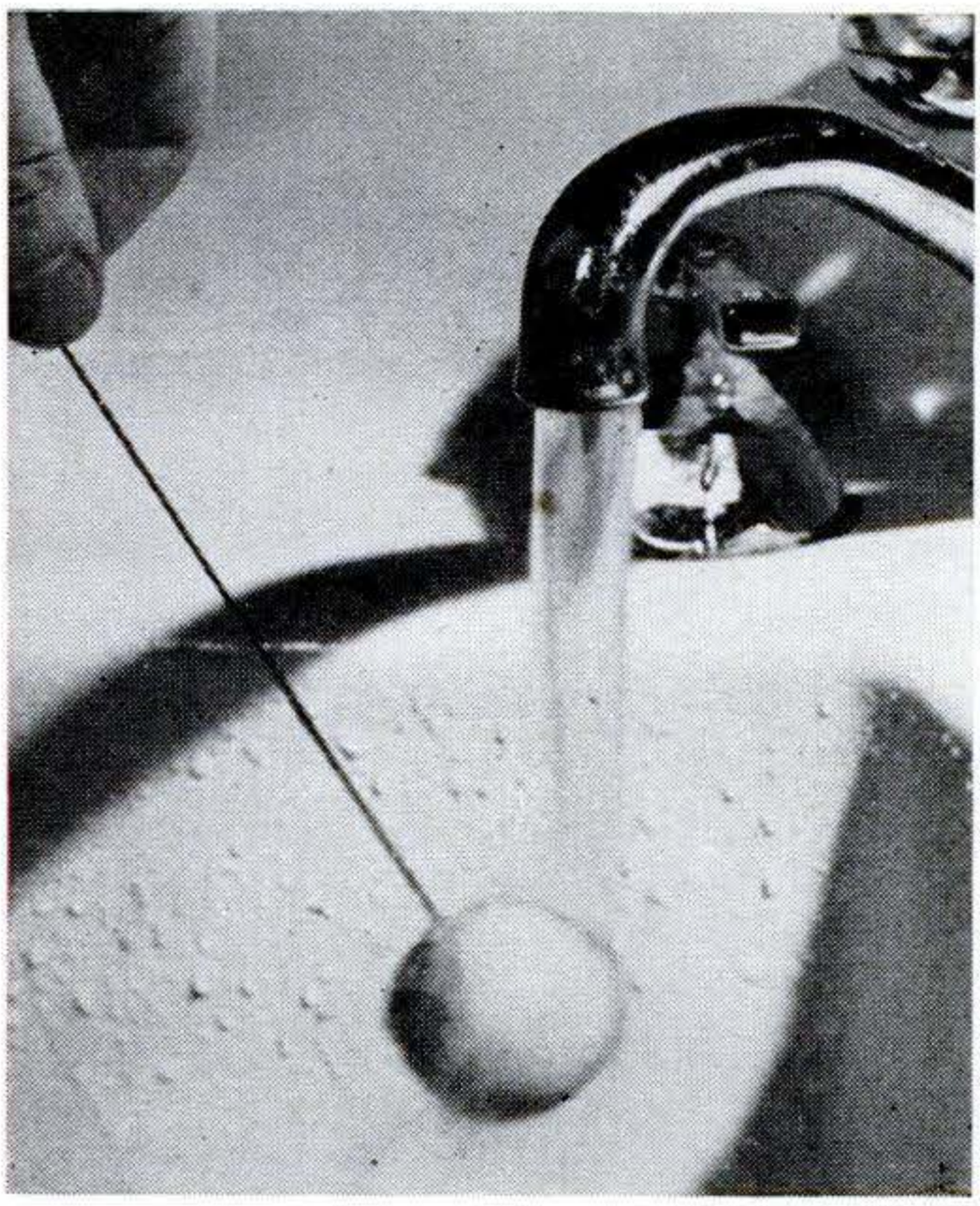
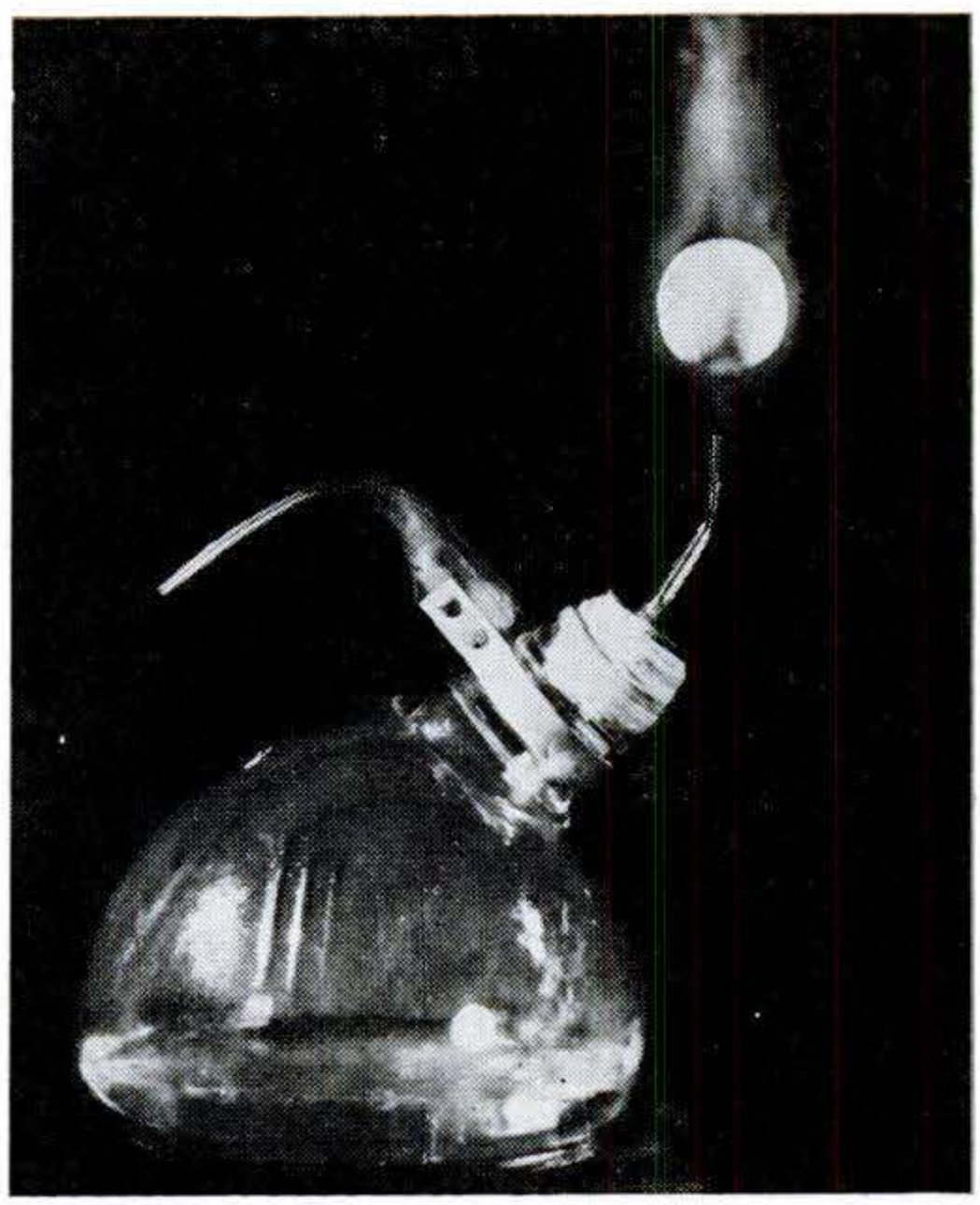




Tube Loops Through the Air. The lifting effect of rapid movement through air—a part of the Bernoulli principle that is very important in aviation—may be tested with a yard of ribbon and a light 1½″ by 12″ mailing tube. Loop one end of the ribbon around a stick and wrap the remainder around the center of the tube. Give the stick a quick pull. If the tube is light enough and the pull fast enough, the tube will rise in the air and describe one or more graceful loops as shown above.



Which Is Greater? Strange as it may seem, the static or internal pressure inside a stream of water is less than the pressure of the still air outside. If you doubt it, attach a string to a table-tennis ball and place the ball under water running from a faucet. Although you hold the string at a considerable angle from the vertical, the ball will stay inside the stream. Every time it tries to get out, the greater pressure of the still air outside the stream shoves it back into the low-pressure area within.



Steam Will Balance It, Too. The same ball will remain poised over a jet of steam issuing from a small aperture. Fit a stopper into a teakettle or other narrow-necked vessel, and draw out a glass tube so that it has a hole about 1/16″ across at the jet end. Bend the tube to point upward when inserted through the stopper. With steam issuing briskly from the jet, center the ball just above it. If the flow of steam is uniform, the ball will remain balanced in the jet so long as pressure is maintained.

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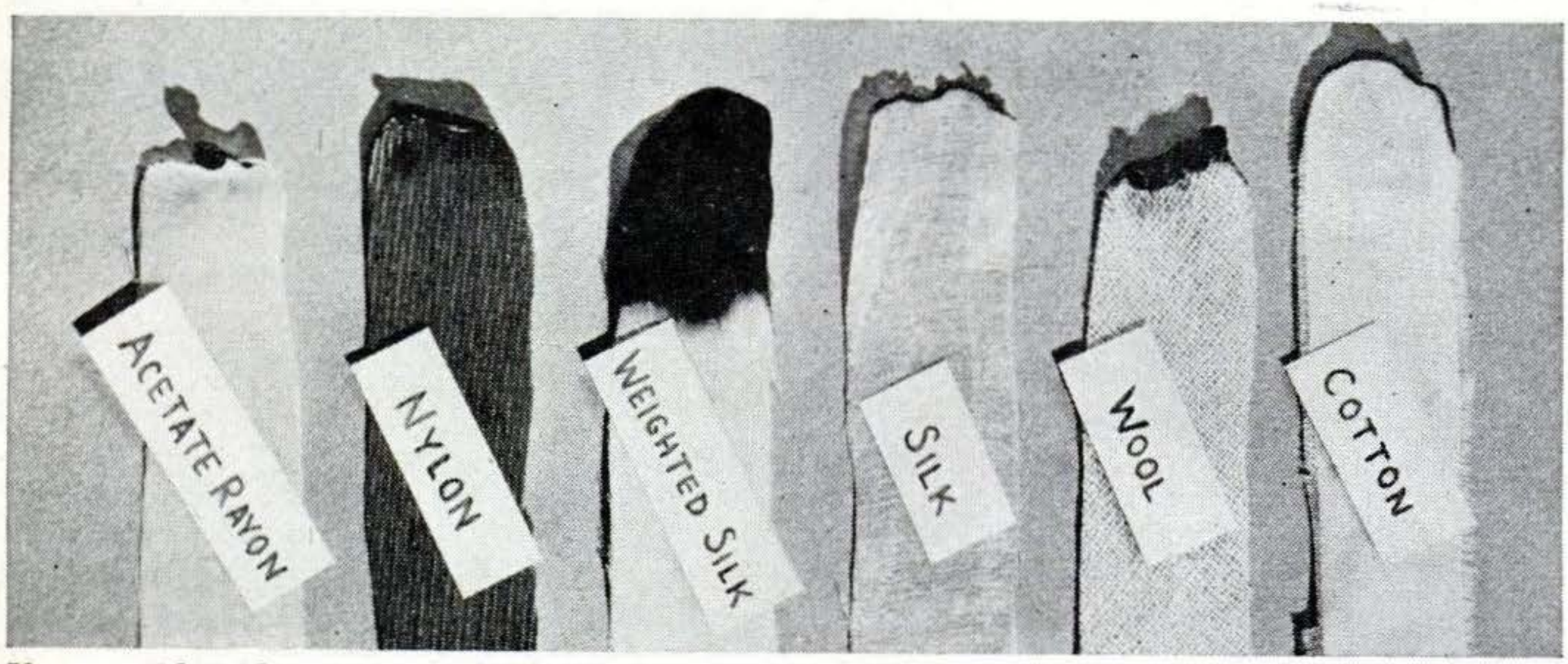
Color changes often give the answer. Here, lead nitrate blackens an alkaline wool solution.



You can identify many textiles by their manner of burning, the odor, and the remaining ash.

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What Fabric Is That?

Various tests in the home laboratory identify textiles and detect some new surface-processing treatments.

By Kenneth M. Swezey

JUST a few years ago, when nearly all textiles were wool, cotton, silk, or linen, almost any housewife could examine a piece of material and tell you exactly what it was made of. Today the situation is vastly different. Competing with these natural products are dozens of test-tube fibers synthesized from wood, milk, soybeans, rubber, glass, and chemical polymers. Further complications confront the tester because of new surface treatments aimed at making fabrics water and moth repellent, flame and crease resistant, nonshrinking, and mildewproof.

Burning a fabric has long been a common test. By touching the edge of a sample to a match flame, withdrawing it, and noting the way it burns, the smell, and the character of the ash, you can differentiate between eight or ten modern textiles.

Cotton, linen, viscose, and cuprammonium rayon all are composed chiefly of cellulose. Consequently, they all burn rapidly with the familiar odor of burning rags or paper. The ash is small, and after the flame goes out a glow may creep along the unburned material. The fibers of these textiles are so similar to each other chemically that they usually are differentiated visually, by the unaided eye or with a microscope.

Wool and hair burn more slowly, giving off the characteristic odor of burning hair or feathers. The ash resembles coke. Pure silk also burns slowly, sometimes emitting sparks, and a row of coke-like beads are left along the edge. Occasionally, silk is weighted by precipitating metallic salts into the fibers. This may add to the attractiveness, but it decreases the cost and often the durability. A burning test readily reveals weighting. Only the silk fibers burn, leaving behind a black metallic ash that retains the structure of the original weave.

Rayons that burn like cotton are made of regenerated cellulose—cellulose that has been taken apart by chemical means and

Decomposition of the component fibers through destructive distillation is one test. A sample is heated vigorously in a test tube that has a strip of moist litmus or lead acetate paper in the mouth. The paper will detect acetic acid, ammonia, or hydrogen sulphide in the vapors.

You may know some textiles by their spots. On a textile containing protein, nitric acid will leave a yellow spot. Iodine makes a black spot if starch was used as a finishing material. A violet or red-brown spot from iodine indicates that dextrin was employed as filling material.

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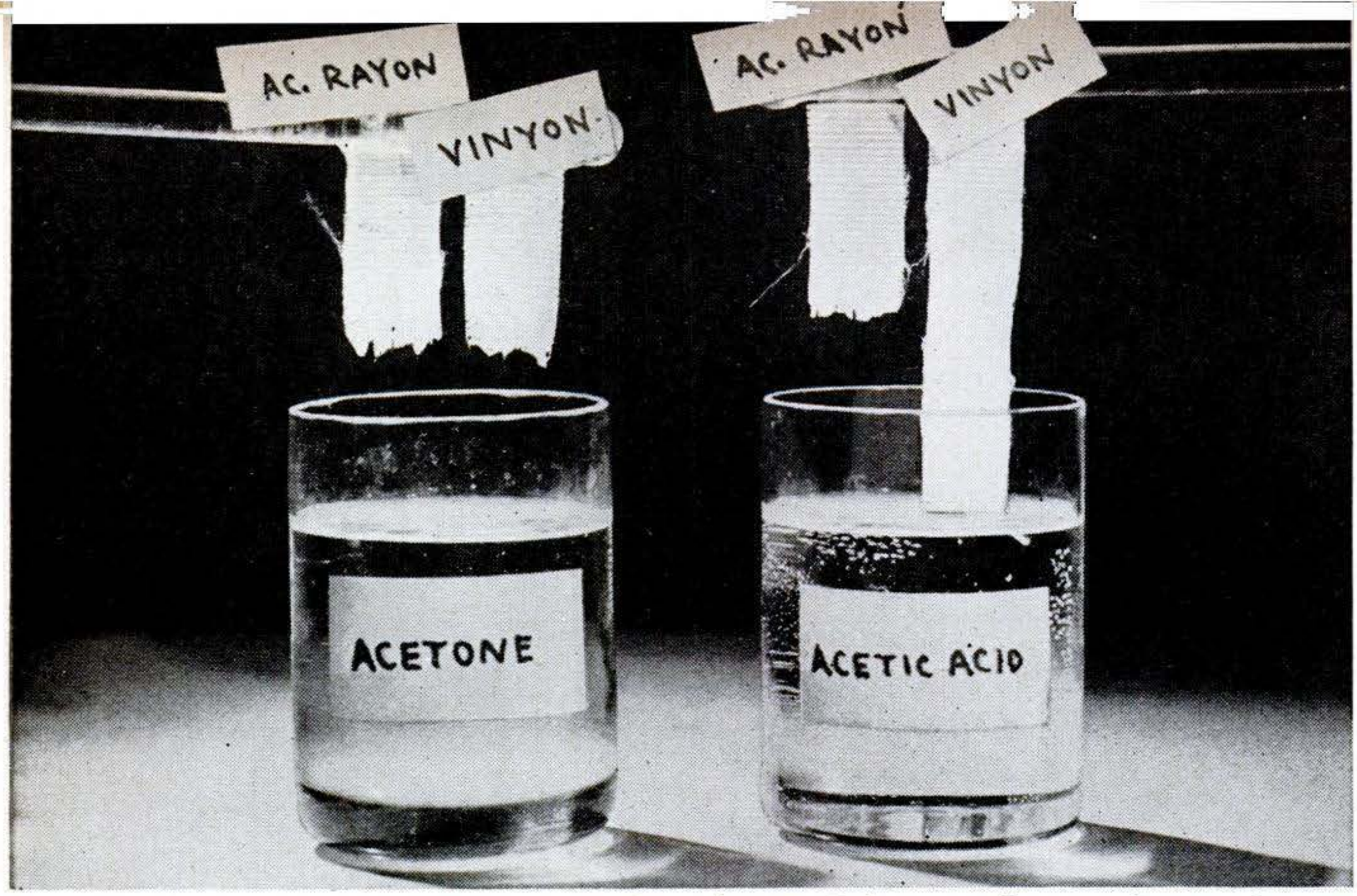
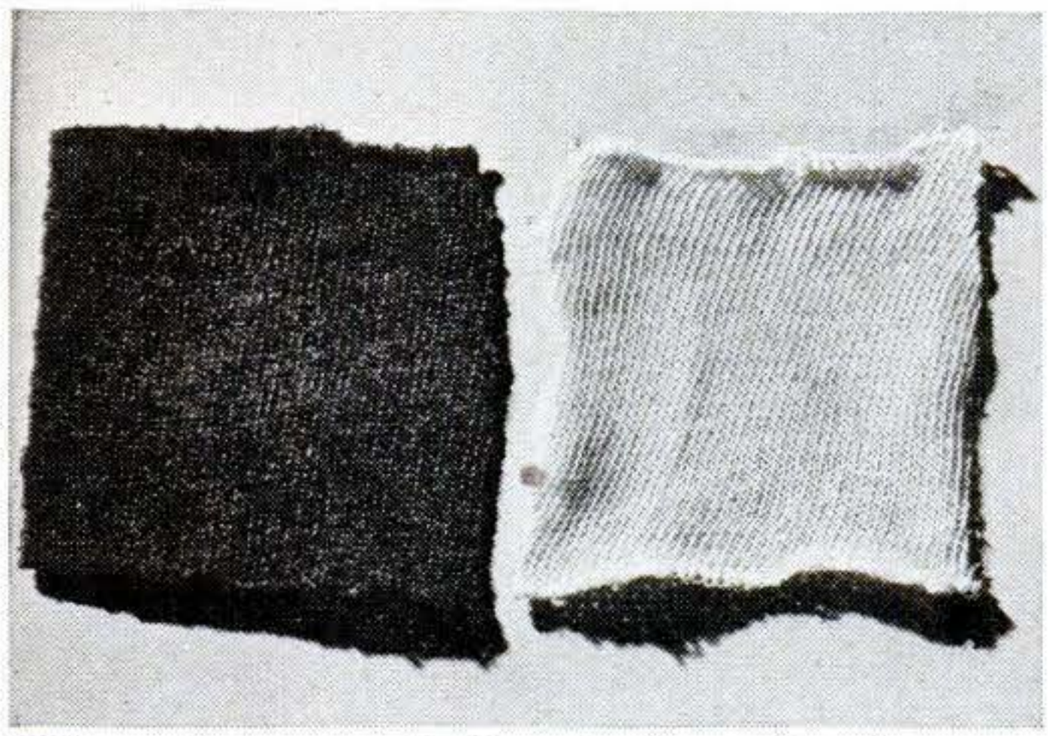


If a textile dissolves in acetone, you can be sure it's either acetate rayon or vinyon. To distinguish between the two, dip samples into acetic acid. Only acetate rayon will dissolve.

put together again. Unlike these, acetate rayon is a definite chemical compound of cellulose with characteristics peculiar to itself. In burning, acetate rayon flames and melts, producing a black ball that drips like sealing wax and hardens when cold.

Aralac, a material resembling wool now made in considerable quantity from skim milk, burns much like wool. Its odor, however, is milder because it contains almost no sulphur, the element that contributes the characteristic smell of burning wool. Pure nylon will not burn, but combustible dyes or finishes may make it inflammable. It melts, however, leaving a brown mass at the edge of the fabric.



When cloth is made from both wool and cotton, boiling it in a sodium hydroxide solution will dissolve the wool. At the left is a colored sample of such cloth. At the right only cotton remains after it was boiled. In this case, the sodium hydroxide also removed the color.

Another new material that likewise does not burn is vinyon, made by causing vinyl chloride and vinyl acetate to join together and form long chain molecules. However, it melts completely at the boiling point of water. The melted mass is tan or brown, much like melted nylon.

Decomposition by destructive distillation affords another way of identifying the component fibers of textiles. This test makes it possible to distinguish between vinyon and nylon, silk and rayon, and wool and aralac—and also to determine whether material has been treated with formaldehyde and urea for crease resistance.

Such a test may be carried out by putting a small sample in the bottom of a test tube and heating the tube over an alcohol or Bunsen flame. The organic matter will break down, producing vapors that will leave clues on moistened strips of neutral litmus and lead acetate papers supported in the mouth of the tube.

When thus broken down, wool, silk, aralac, nylon, and textiles processed with a urea finish will release ammonia and turn the litmus paper blue. If the material is not nylon, as can be found out by the previous burning test, and if it contains no protein,

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as determined by a nitric acid test to be described later, the presence of ammonia can be taken as indicating the use of the formaldehyde-urea crease-resistant finish.

Except when this finish has been used, cotton, linen, rayon, and vinyon all give off acetic acid vapor instead of ammonia when distilled in the test tube, and the litmus paper turns red. Of all textile materials, only wool and hair produce enough hydrogen sulphide to turn the lead acetate paper gray or black.

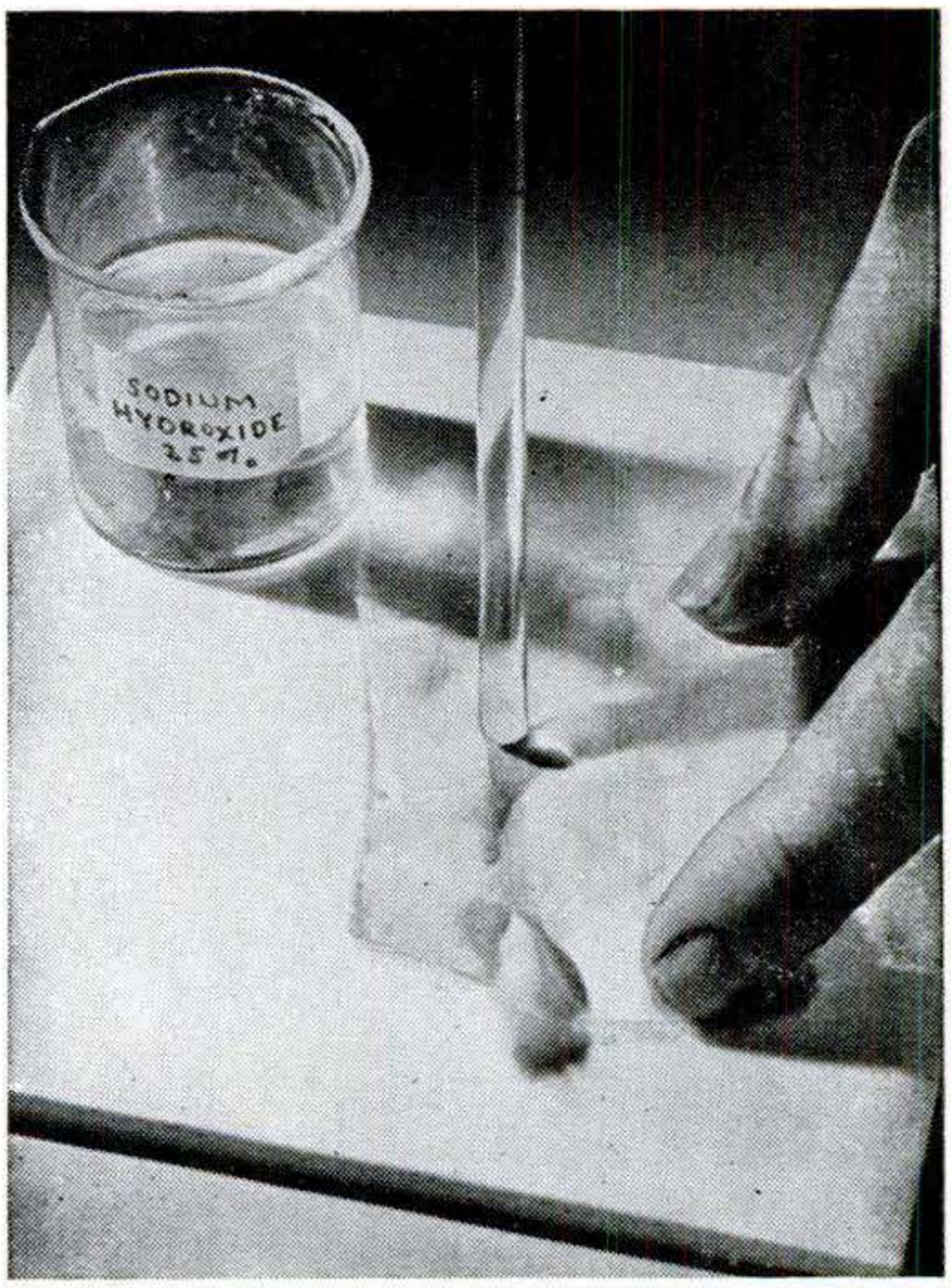
Distinctive color changes produced when samples are treated with chemical reagents also may help identify textiles and filling materials. Silk, aralac, soybean fibers, wool, and hair will all dissolve if boiled for 10 or 15 min. in a 5 percent solution of potassium or sodium hydroxide. Add a few drops of lead nitrate solution to part of the resulting alkaline solution of fiber. If this produces a black coloration—due to the formation of lead sulphide—the textile is either hair or wool.

Boiling likewise will enable you to determine the proportion of the fibers just mentioned that may be mixed with cotton, rayon, or nylon. In the process, the protein fibers will be destroyed, leaving the cellulosic or nylon fibers unharmed. After rinsing and drying these, you can estimate visually about how much fiber has been dissolved.

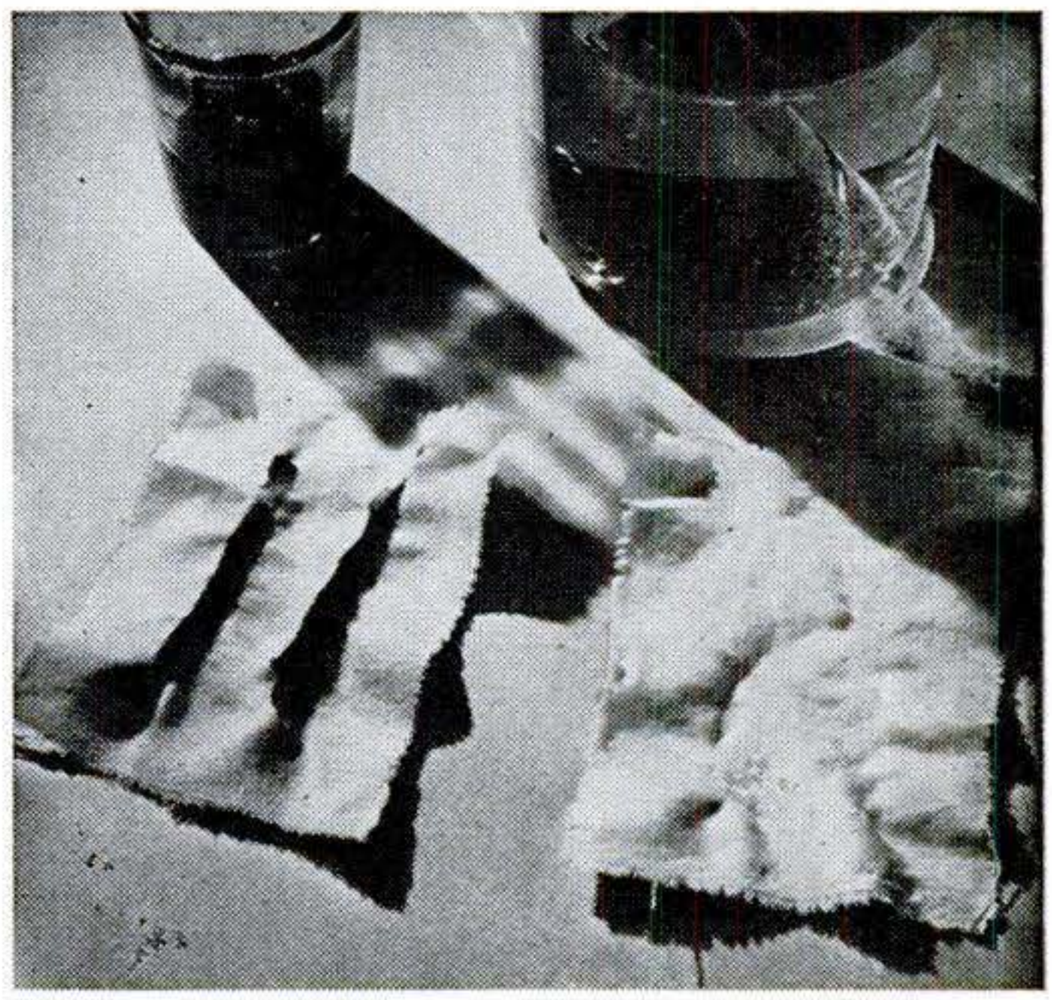
Application of a drop of cold concentrated nitric acid is a means of quickly separating textiles that contain protein (silk, wool, aralac) from those that do not (cotton, linen, rayon, nylon, and vinyon). If protein is present, the spot will turn yellow. The yellow will deepen if concentrated ammonium hydroxide is added.

Starch or dextrin as a filling material may be detected in white or light-colored fabrics by applying a drop of a solution of ½ gram iodine and 2 grams potassium iodide in 100 ml. water. If starch is present, the spot will turn a deep blue-black. Dextrin gives a violet or reddish-brown spot.

Mercerizing has long been a popular finishing treatment for cotton. If cotton cloth is free from starch, as determined by the iodine test, you can check for mercerization with a special solution of iodine. Prepare 10 ml. of a saturated solution of potassium iodide and in it dissolve 2 grams iodine crystals. Dip a mercerized sample into this for a minute, rinse thoroughly, and dry. The sample will be left a deep blue-black. If you use an unmercerized sample it will be almost colorless, or yellowish. END



Mercerization, a popular finish for cotton, is accomplished by subjecting the cloth to a cold sodium hydroxide solution for several minutes, stretching to prevent shrinking, neutralizing with weak acid, and then washing. If a cotton sample is treated with a 25 percent solution, applied in lines with the tip of a glass rod as above, and is then washed and dried after 2 min., the effect at right below will result.



Shrinkage of the mercerized lines caused the sample at the right to pucker. Cotton crepes are sometimes made in this way. Test a similar sample for mercerization with a strong iodine and potassium iodide solution and you get the result at the left. Parts that are mercerized take on a deep blue-black color, as seen here by the dark lines, while the areas that were not mercerized fade to a brownish yellow.

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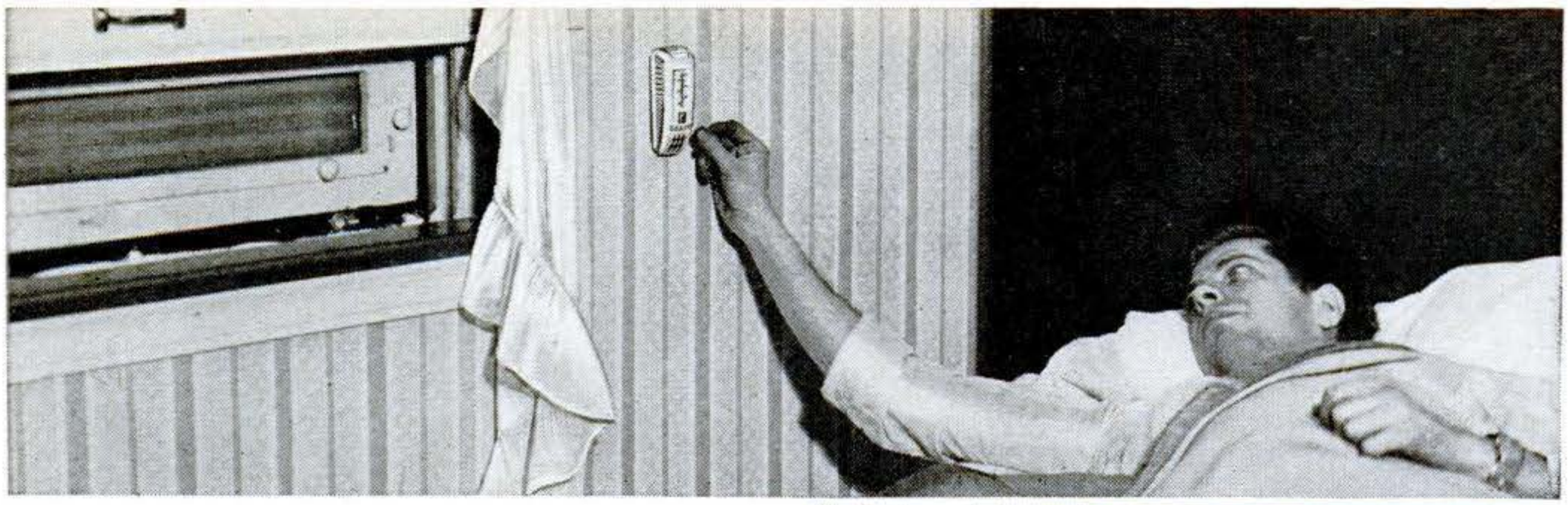
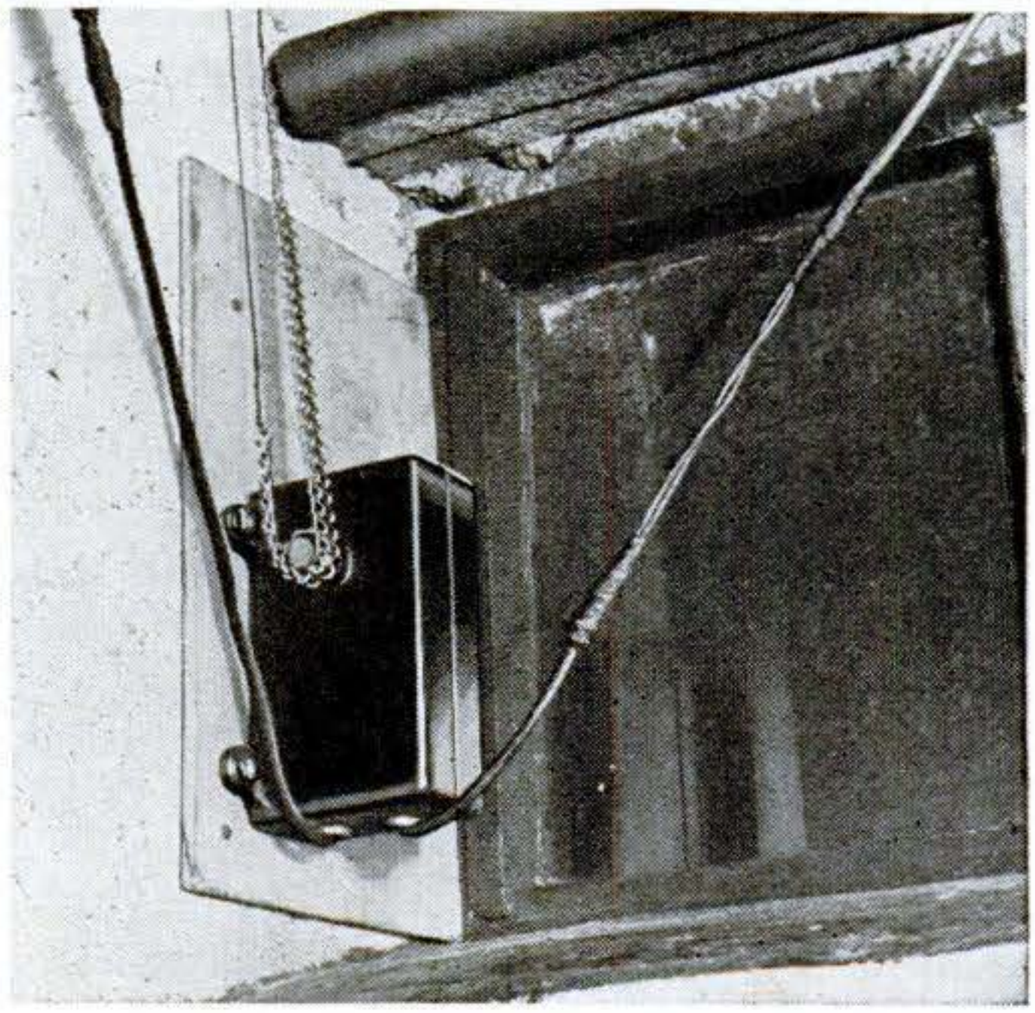


Thermostat Operates Window

WITH a thermostat and draft-operating motor from a heating system, a window may be rigged up to open and close automatically at a predetermined temperature, so that a sleeper will neither be chilled nor deprived entirely of fresh air.

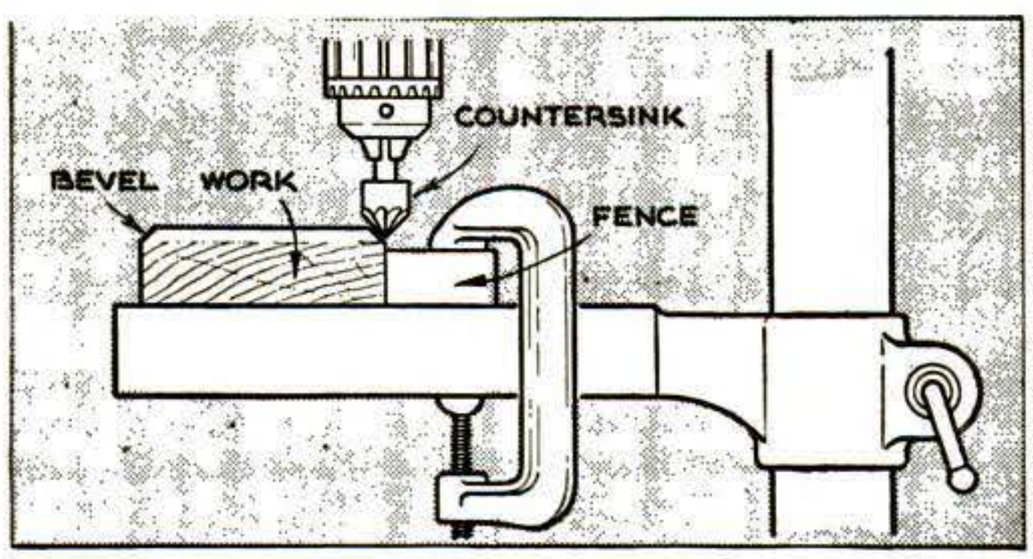
In my home the motor was mounted in the cellar directly under the window, as at right, and lengths of piano wire were attached to both ends of the drive chain. One wire runs up through the wall to the bottom of a first-floor bedroom window, the other to a pulley above the window and down to the top of the same sash. To open the window fully, the chain must be slipped off the motor.—WILLIAM B. SCHWAB.



Can Halves Are Parts Trays

IF THE shelves near your workbench are cluttered by miscellaneous boxes laden with screws, bolts, brads, washers, and the like, you may find a few trays cut from tin cans a real convenience. The rounded bottom makes it easier to pick out elusive small parts.

Save the lids if the cans have been opened with a rotary opener. After cutting the can in half, bend a ⅛" fold all around to provide a safe edge, and solder a similarly folded half lid to the open end. Also solder a U-shaped strip of tin-can stock under the tray to prevent rolling.



Countersink Cuts an Even Bevel

RUN at high speed in a drill press, an ordinary countersink will put an even 45-deg. bevel all around a piece of work. Use a fence on the drill table, clamping it just underneath the point. The size of the bevel may be adjusted by raising or lowering the height of the countersink to take a smaller or larger cut.—HERBERT PFISTER.

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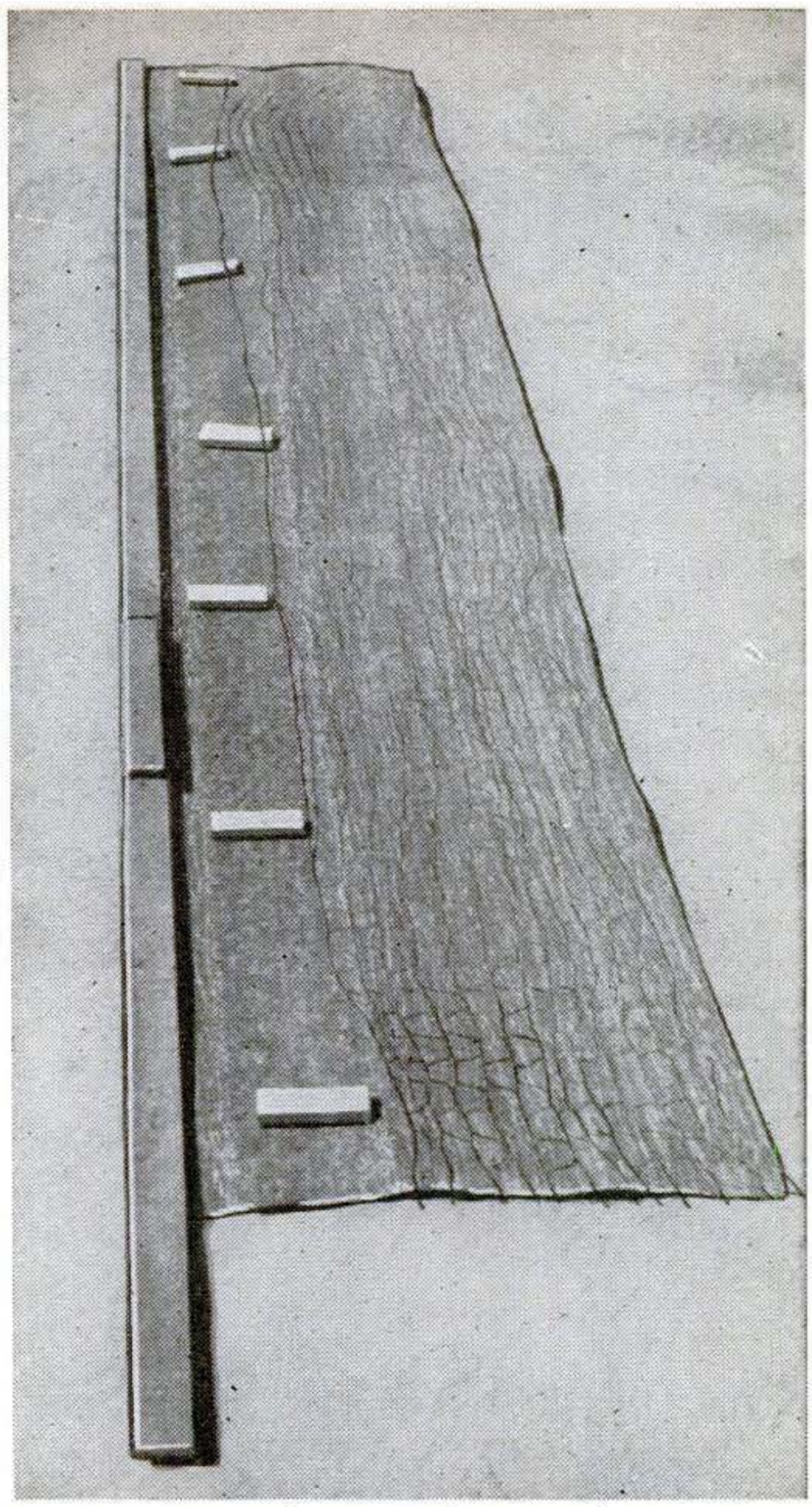
Concrete Drain Is Cast over Form

WHEN 4″ pipe with seepage outlets was needed to complete the drain for a septic tank, and neither soil pipe nor drain tile could be found, concrete pipe was manufactured by the steps illustrated.

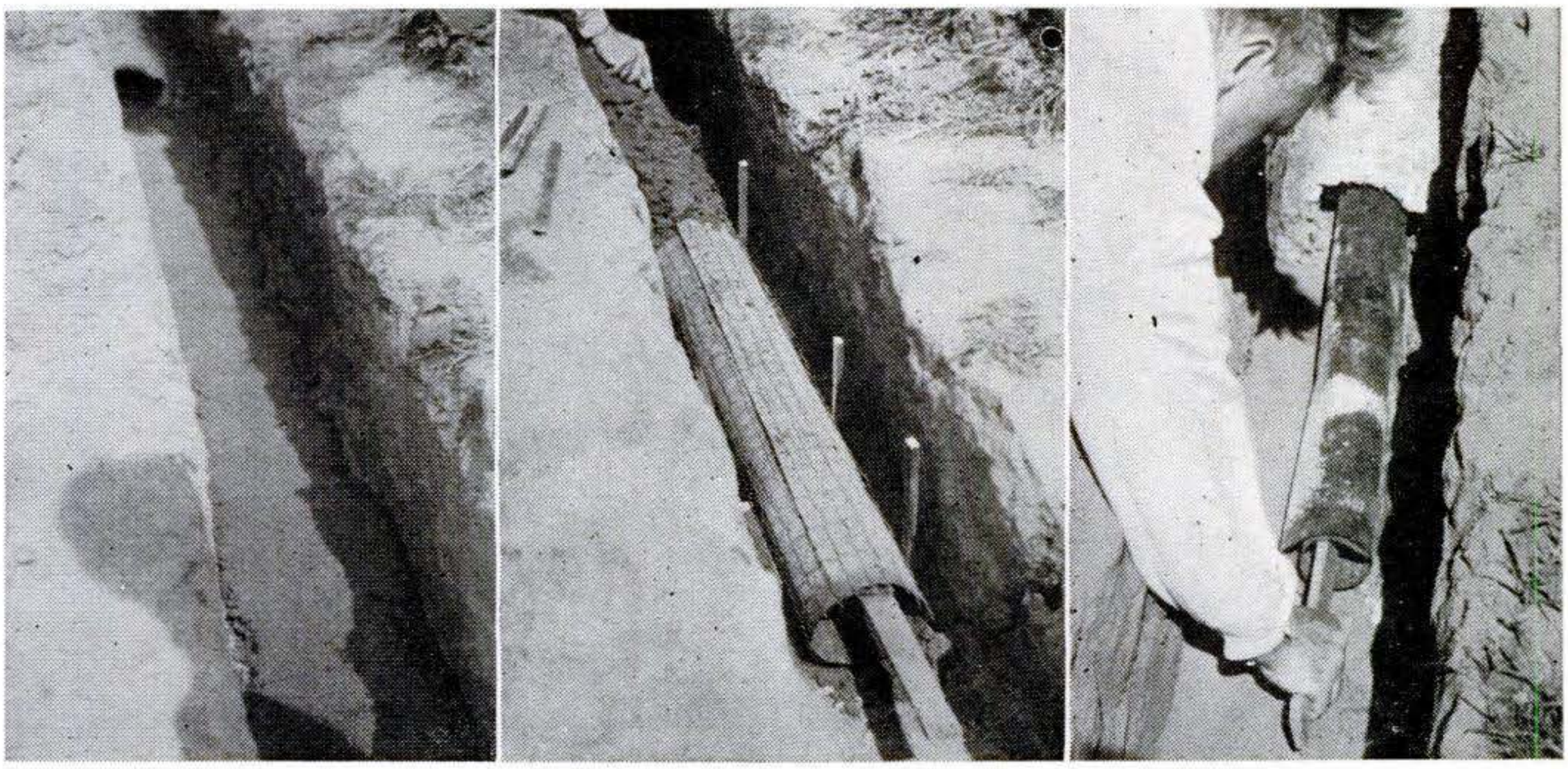
The trench was dug and graded for drainage, and then filled with a 1″ layer of concrete. This was smoothed with the back of a round shovel to give a slight hollow along its length. Roofing paper 20″ wide by 10′ long was used as the inside form; an 11′ wood strip nailed along one edge both reinforced the paper and provided a handle. The paper was coiled in the trench around a number of 3½″ spacer blocks. Over this a 12″ by 10′ piece of 1″ poultry netting was tucked down and staked at the sides. About 1″ of concrete was then troweled in all around.

When the concrete had dried, the spacers were knocked free with a long stick. A twist of the wooden handle narrowed the diameter of the form and made it possible to pull out the paper tube.

Starting 20′ from the house, seepage outlets were made by placing small quantities of gravel next to the tube and troweling over them. Outlets were spaced about 24″ apart, and a small rock-and-gravel pit provided at the end of the pipe to allow for overflow drainage.—V. O. HANSEN.



Roofing paper becomes the pipe form. Spacer blocks govern the size and shape of the tube.



The trench is dug and floored with concrete. After the paper form is inserted, it is covered with wire netting. Temporary stakes hold both in place while the concrete is poured. When the concrete is dry, the handle of the tube is twisted and the roll is pulled free.

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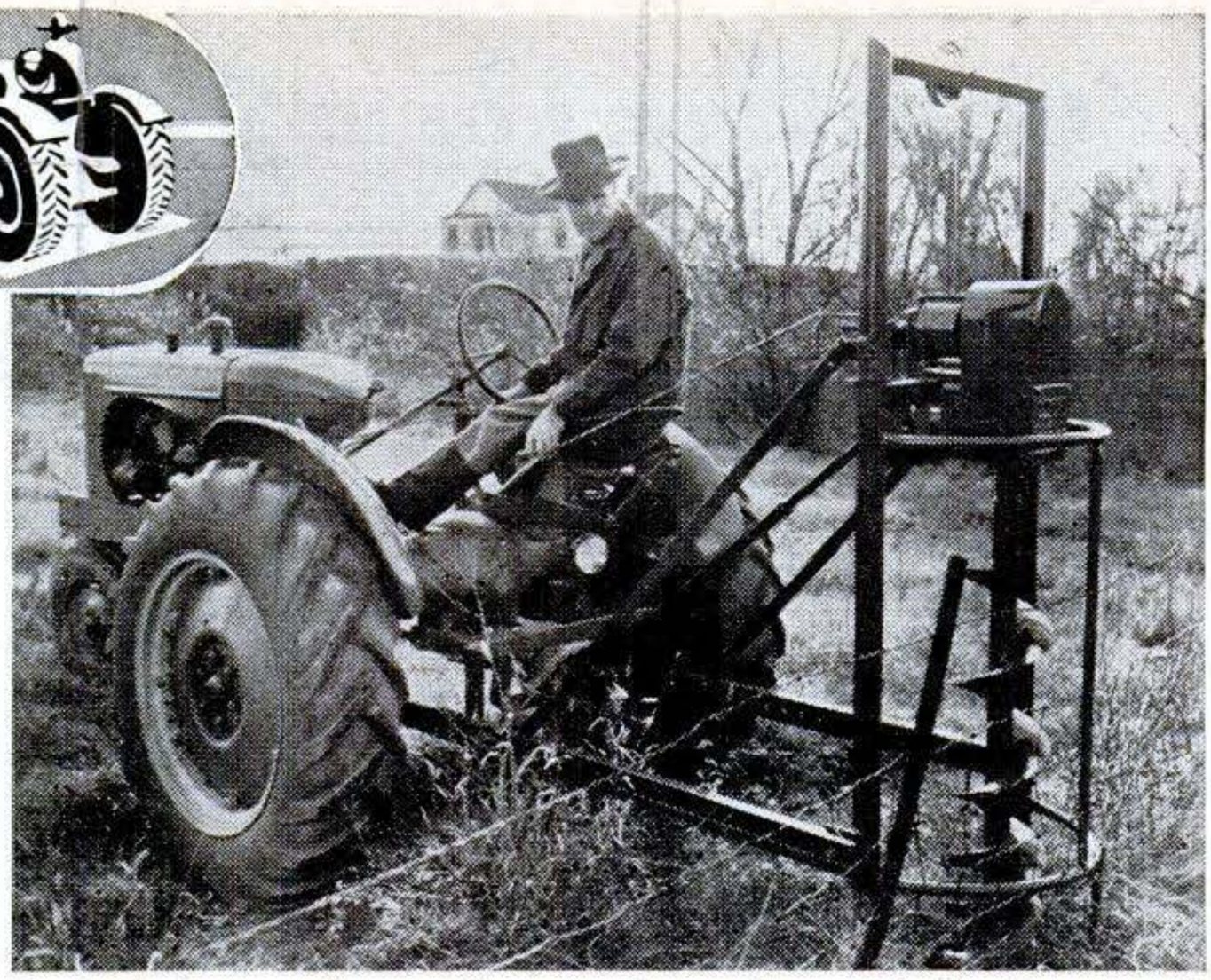
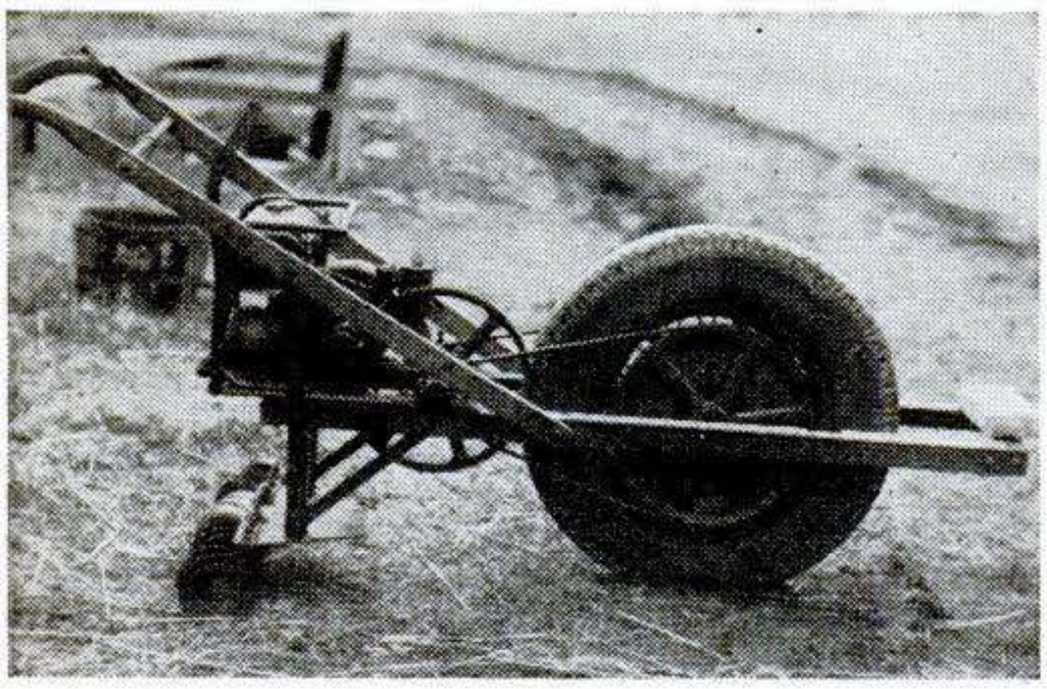
FOR EASIER FARMING

Digging Postholes. A new tractor-driven posthole digger is equipped with a fence guard that permits replacing posts in the fence row without disturbing the standing fence. The digger is also adjustable forward and backward to work at an angle or on a hillside. It is made in two models for hydraulic-lift and rear-end power takeoff tractors by the Winpower Mfg. Company, of Newton, Iowa.



Backed into a fence, the guard on the posthole digger will push the wire out enough for alignment of the hole in the row.



Tractor Is Farm Built. Power supplied by a 1-hp. light-plant motor is transmitted to the automobile wheel of this garden walking plow through two reduction hookups. The first is to a gear on a jackshaft and the second from the shaft by double-pulley belts to the wheel. Operation is by a throttle and clutch lever on the plow handles. A lead brick on the front of a welded angle-iron frame serves as a counterbalance. The tractor was built by Leonard L. Higgins, of Poulsbo, Wash.

Wagon Made Like Auto. With an all-welded frame, a new farm wagon on truck-type wheels is available with optional equipment for use as a trailer-wagon or a horse-drawn vehicle. It has a reach adjustable to give an 8′ to 12′ wheelbase and carries a 3-ton load at 20 m.p.h.—5 tons with oversize tires. The Duro wagon is distributed by Mercury Sales Company, Detroit.

Radio Waves Grade Eggs. Development of an electronic egg grader, said to be the first successful mechanical method, is announced by Prof. Alexis L. Romanoff, of Cornell University, Ithaca, N. Y. Eggs are graded on their ability to absorb electronic energy (good ones absorb less than bad) from short radio waves when placed in a coil. Their conductivity, automatically corrected for egg weight, is registered on a meter. The grader is so sensitive that it reveals even the degree of freshness, but it does not replace candling in disclosing blood spots and similar faults.

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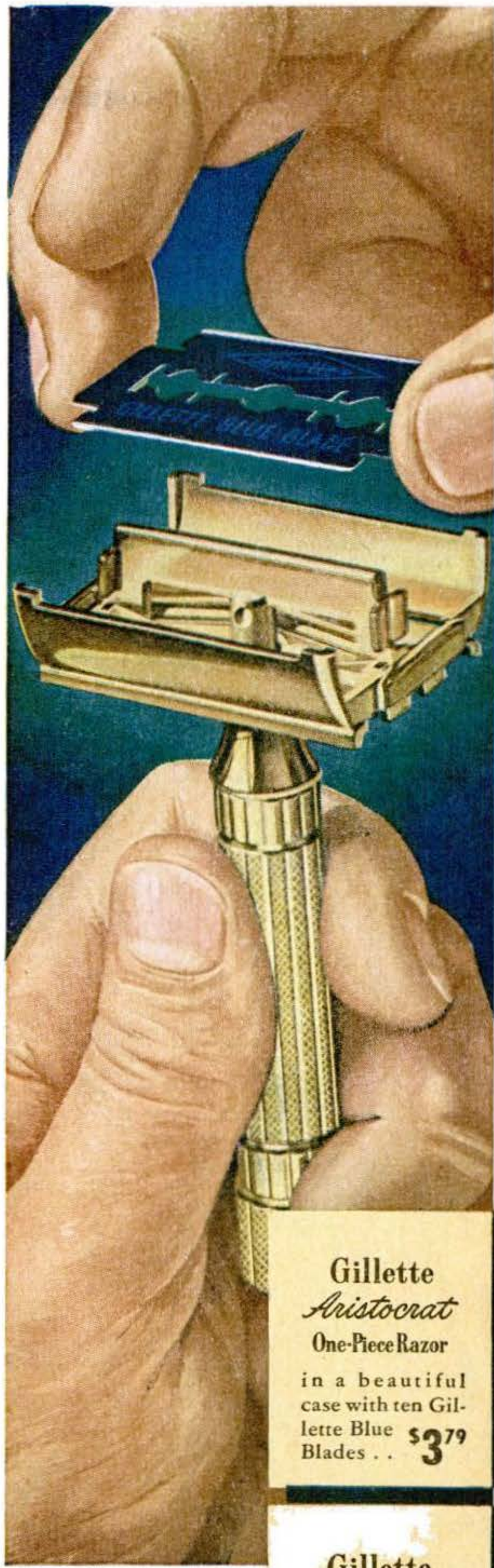

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Twist...It's Closed

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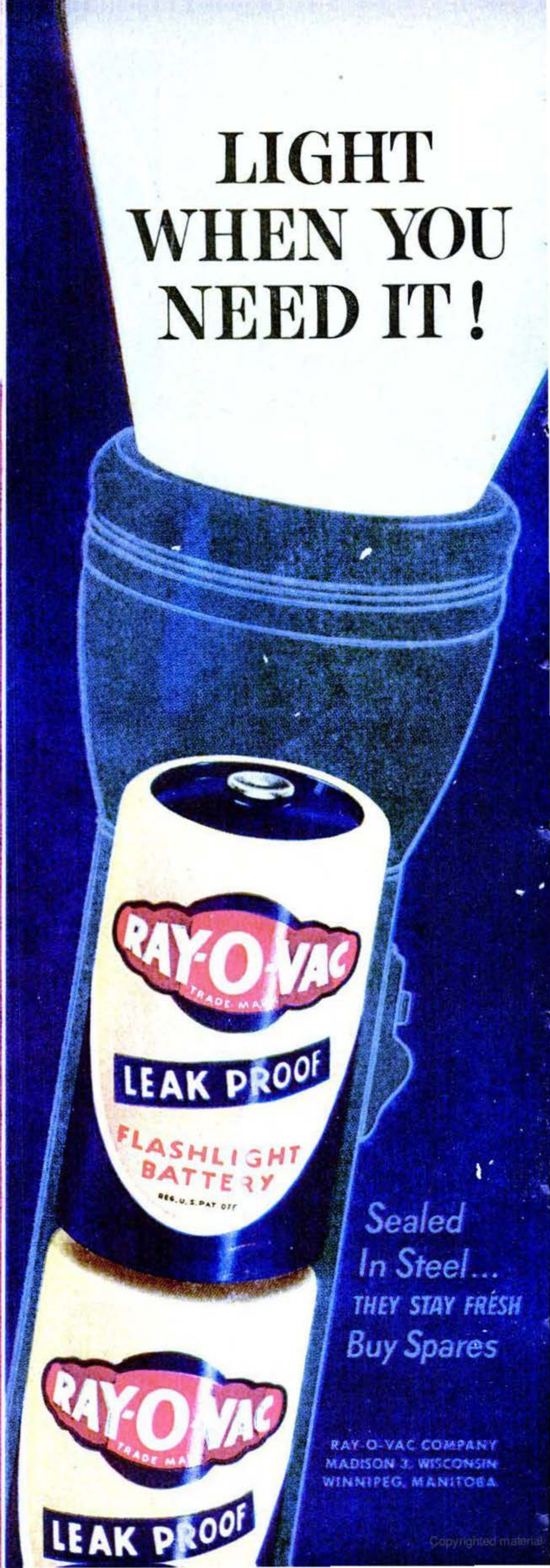

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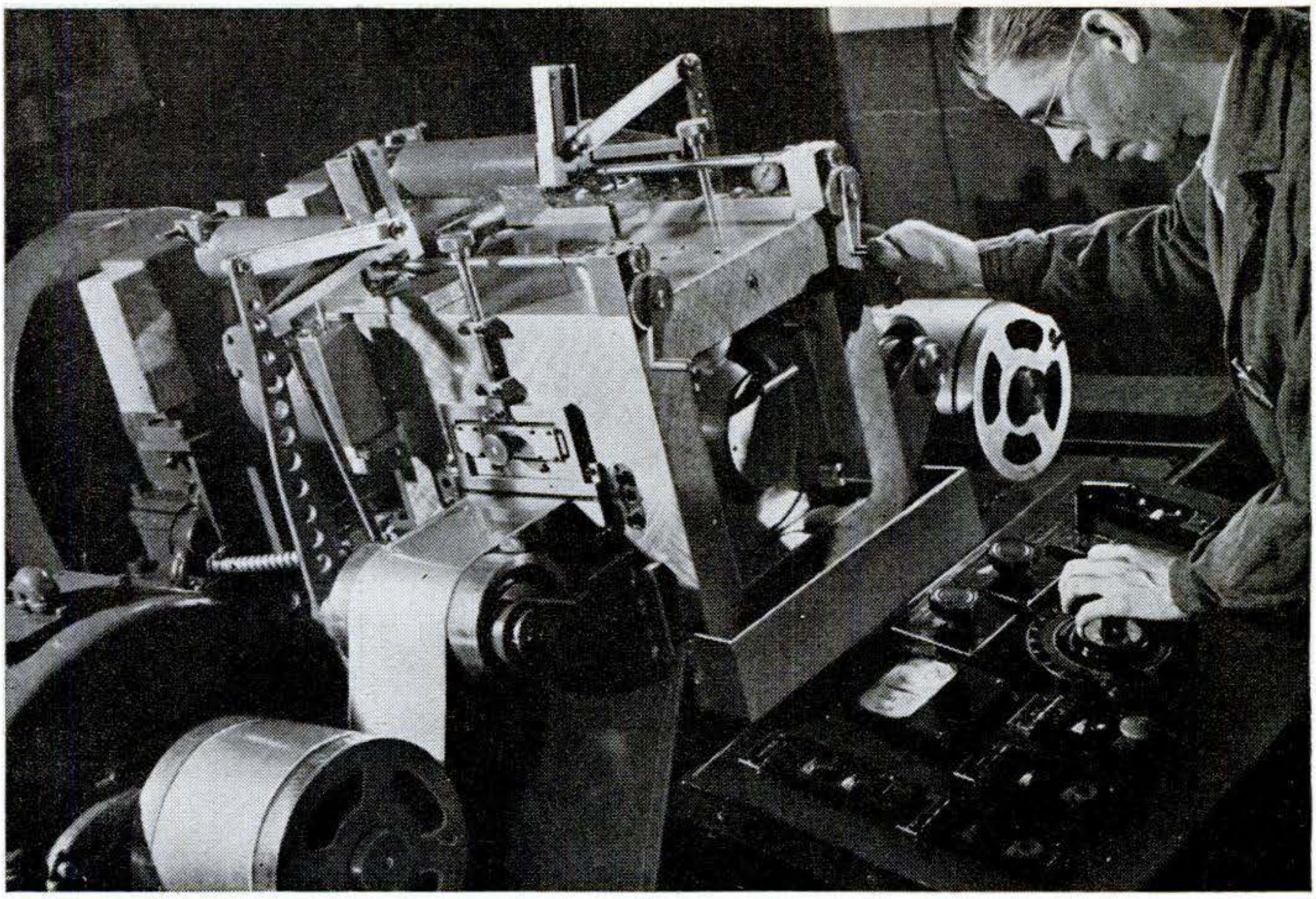
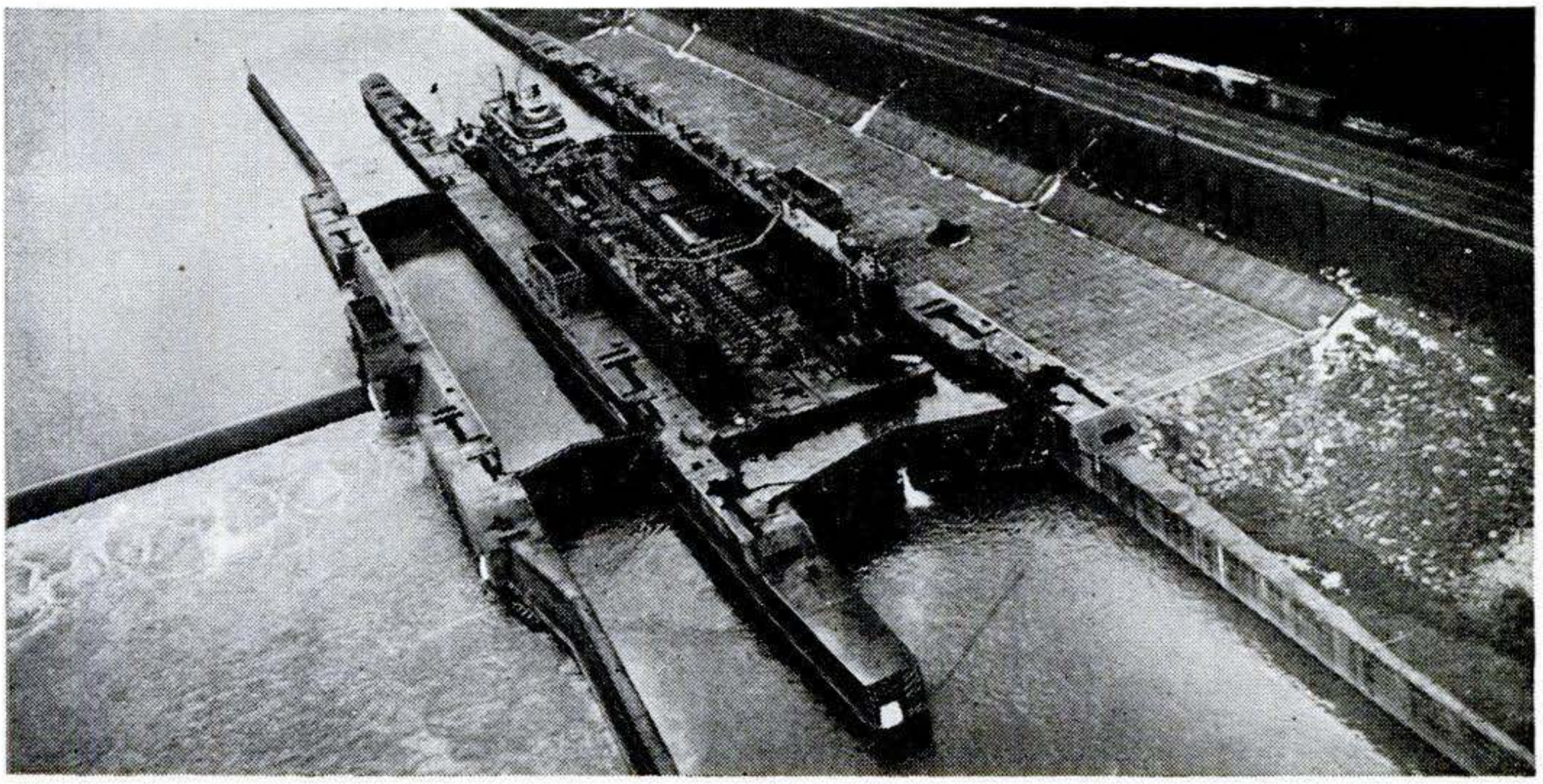


Miniature Metal Mill

THIS tiny rolling mill, a miniature of those in giant steel plants but up to 40 times more powerful, can squeeze metal until it is thinner than tissue paper. Built for Westinghouse, its two small rollers pull 100-foot strips back and forth at speeds up to 200 feet a minute, rolling them into mile-long lengths only 1/2,000 inch thick.



Drydock Goes to Sea

LARGEST vessel ever launched on an inland river, this Navy floating drydock slips easily through the Dashields Locks on the Ohio River on its 2,000-mile trip under tow from Pittsburgh to the Gulf of Mexico. The huge craft, 448 feet long and 97 wide, sleeps 137 crew members and can lift 6,000 tons. It was built by Dravo Corp.

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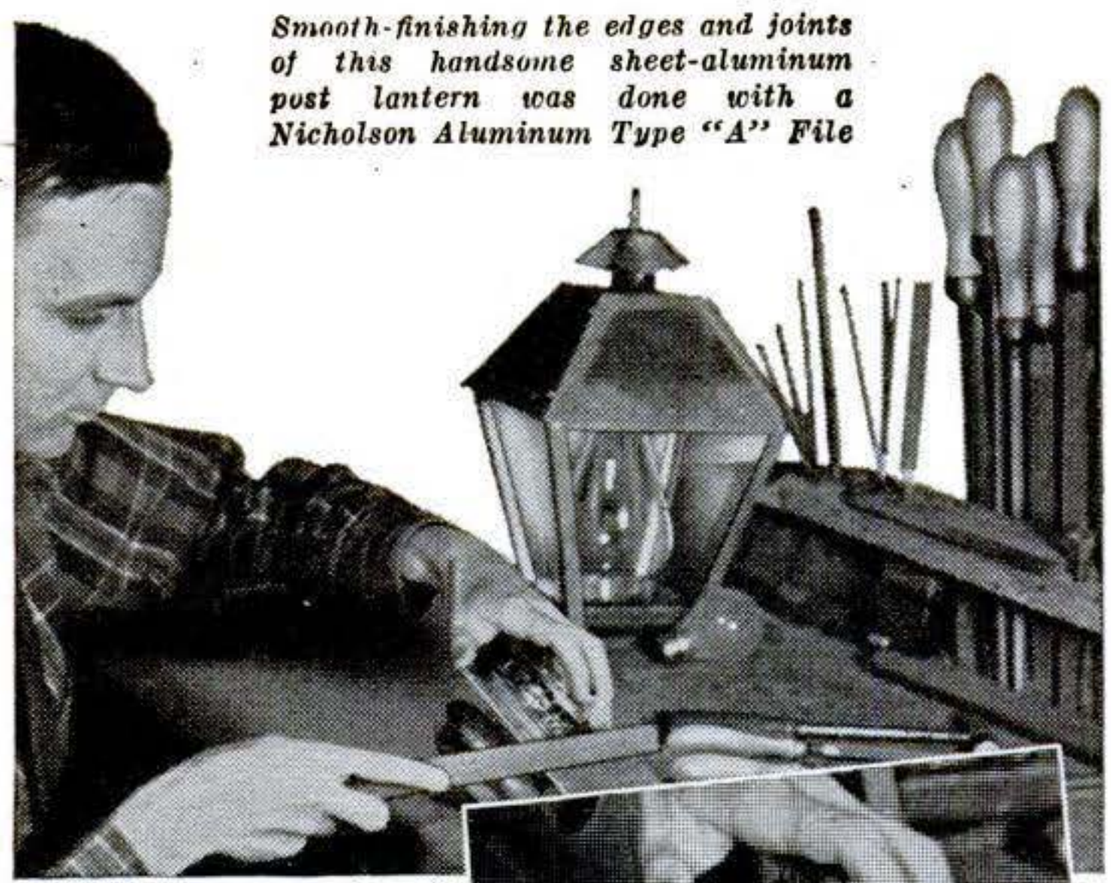

Smooth-finishing the edges and joints of this handsome sheet-aluminum post lantern was done with a Nicholson Aluminum Type "A" File

"Basement craftsman" who knows his files

Having the right tool for each job not only multiplies the fun of home-workshop hobbying, but also speeds the development of mechanical skill. And no hand tools offer a wider range of applications or conditions than *files*.

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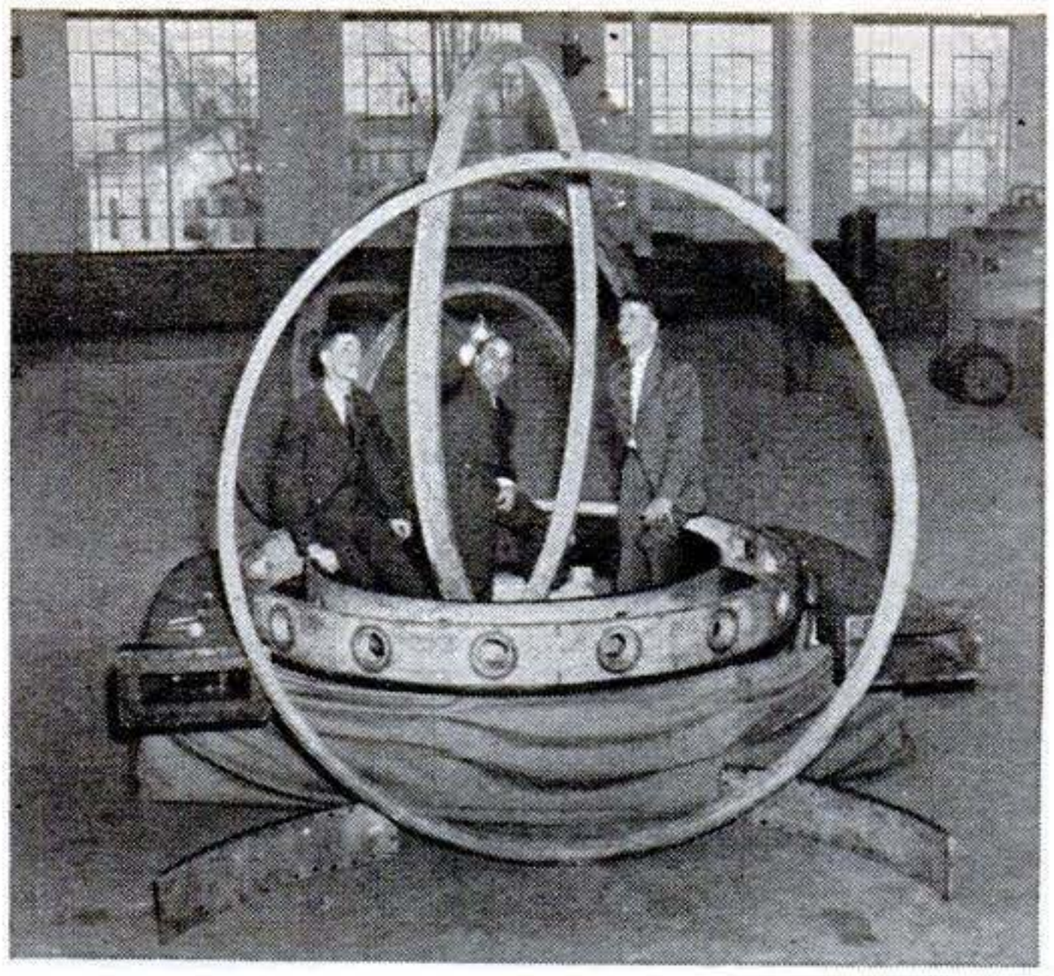
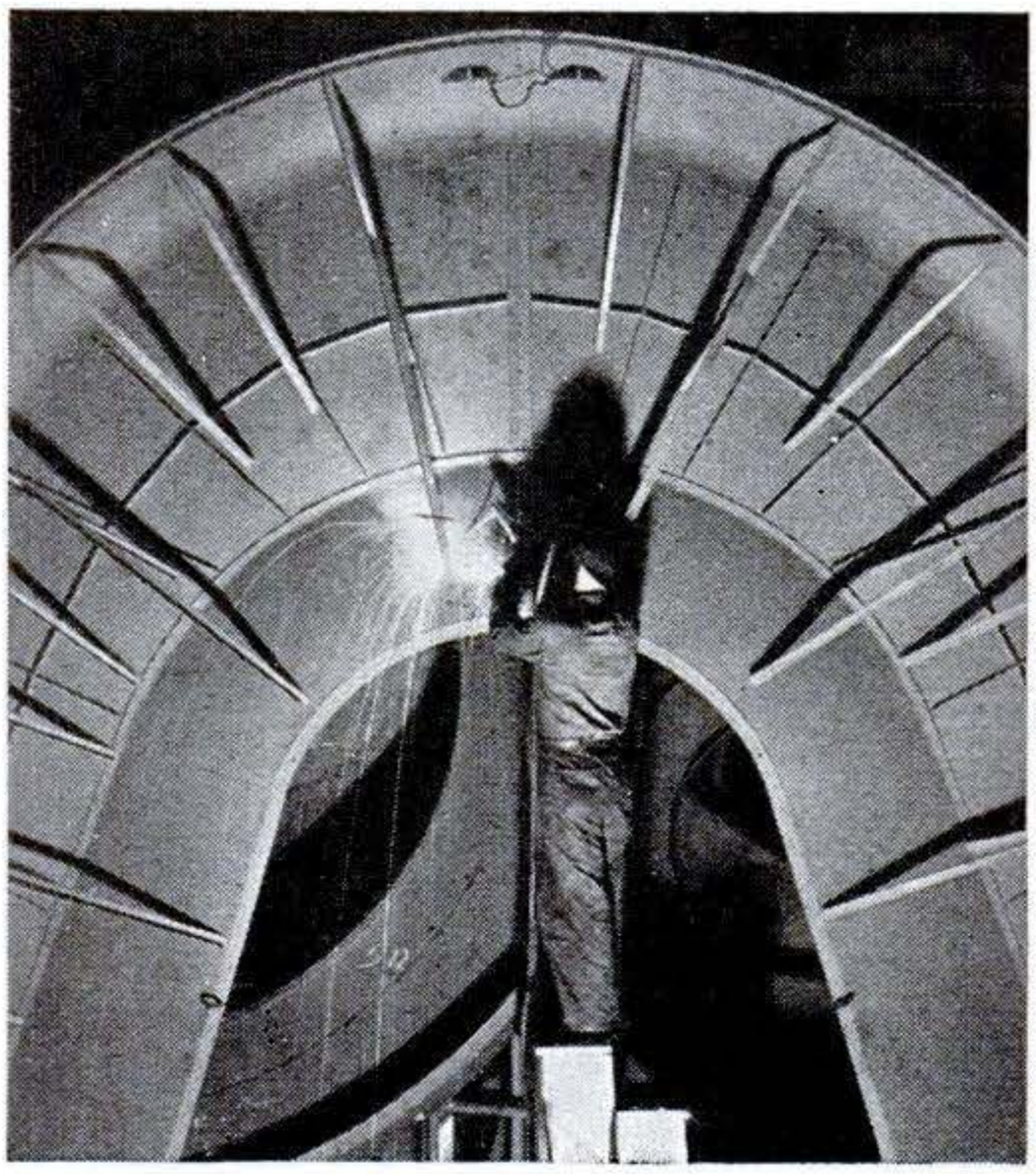


Plastic Aids Atom Work

THESE giant hoops are part of the seven plastic rings and three plastic manifolds that will form the vacuum chamber for the University of California's newest atom-smasher. Made by General Electric, the largest part is eight feet in diameter, weighs 650 pounds.



Grooming a Generator

THIS 13-foot-high "horseshoe" gives you a good idea of just how large generators can get. A giant in its own right, it is only an end cover for a huge 133,750-kilovolt-ampere, hydrogen-cooled generator being built by Westinghouse for use in the Midwest. It will help streamline the big generator by covering otherwise exposed water pipes.

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Photo-greeting cards are "personal"— different

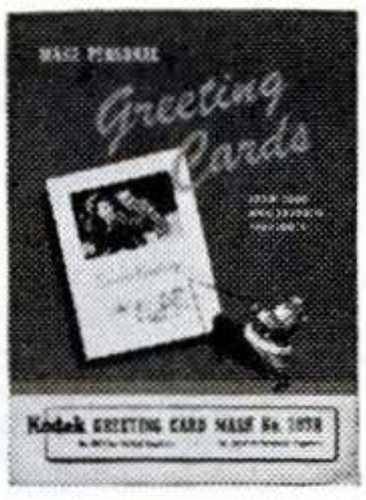
You make them yourself or order from your photofinisher

Photo-greeting cards are fun to turn out with Kodak "masks." You start with a pet negative—you use your own printing equipment—all you need besides are the greeting card supplies shown and described here. See your Kodak dealer.

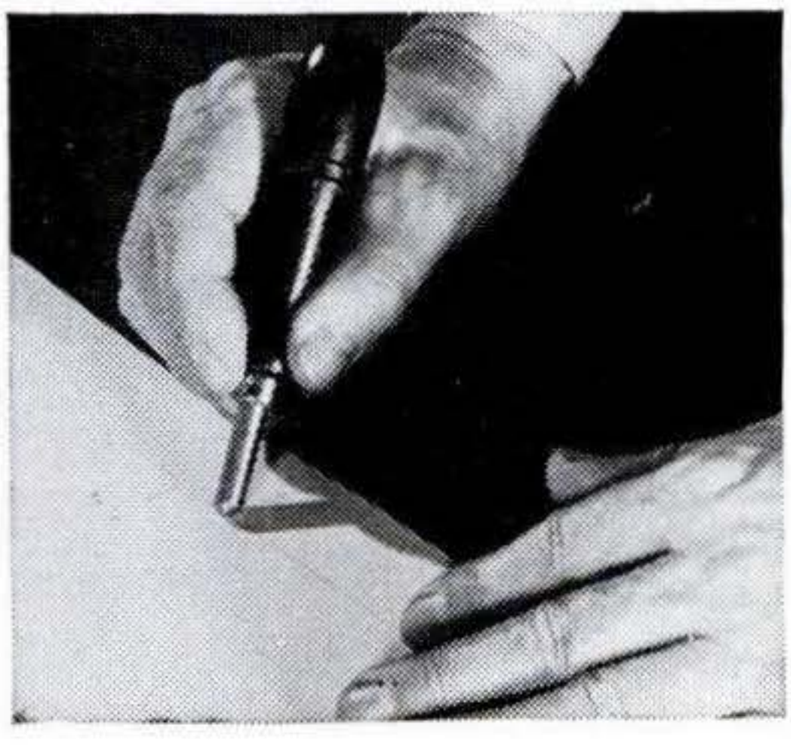
If you are not a darkroom fan, you can still have your own photo-greeting card. Just take a favorite negative to your photofinisher—he will show you a wide variety of attractive designs and do the whole job for you.

EASTMAN KODAK CO., ROCHESTER 4, N. Y.

KODAK EDGE TINTING OUTFIT—2-ounce bottles quick-drying red and green ink . . . four felt nibs and holder . . . Price: $1.50.



KODAK SERIES 20 GREETING CARD MASKS—each mask is a negative with greeting message and cut-out space for *your* 620 negative . . . 2 designs, horizontal or vertical. Price of each mask: 85 cents plus tax.



KODAK AZO E PAPER—ideal for printing photo-greeting cards . . . double-weight, 4¼" x 5½"...straight or deckle edge. Price: package of 25 sheets, 45 cents plus tax; 100 sheets, $1.60 plus tax.

KODAK EMBOSSING GUIDE—easy to use . . . gives each card that custom-made look. Price: 75 cents.

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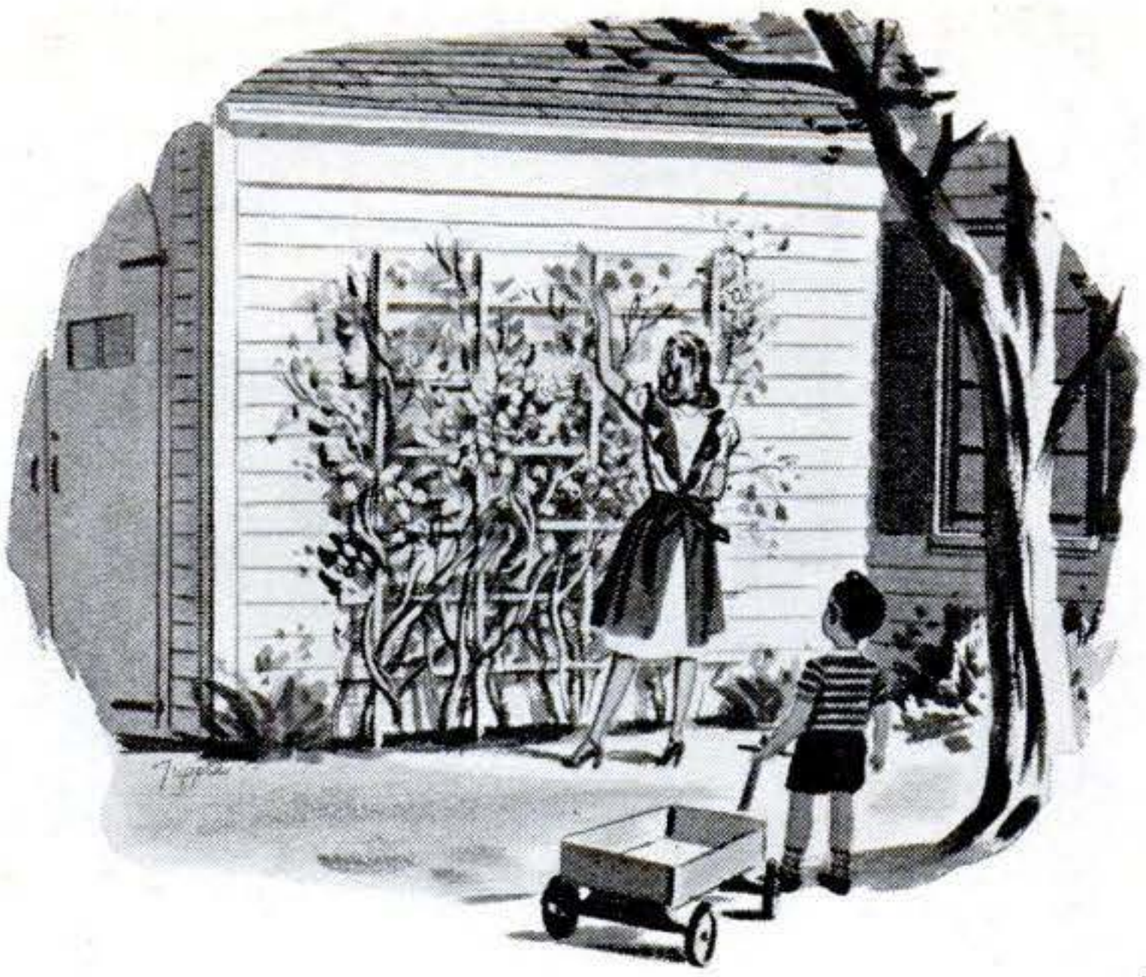
Plant roses where the woodpile used to be!

Modernize your home with a Perfection Oil Heater and you'll be able to have a garden where the woodpile was! This is a symbol of the greater comfort and freedom that can be yours with *quality* Perfection heat. You can look to Perfection, as so many others have, for better living!



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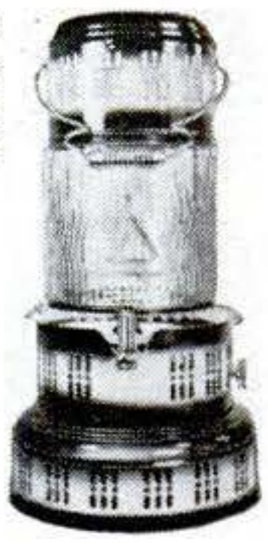
Firelight Portable Model 750 for "spot" heating anywhere



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So, when your car first begins to smoke, use too much oil or lose power, install Hastings Piston Rings at once. They *stop* oil-pumping, *check* cylinder wear, *restore* performance.

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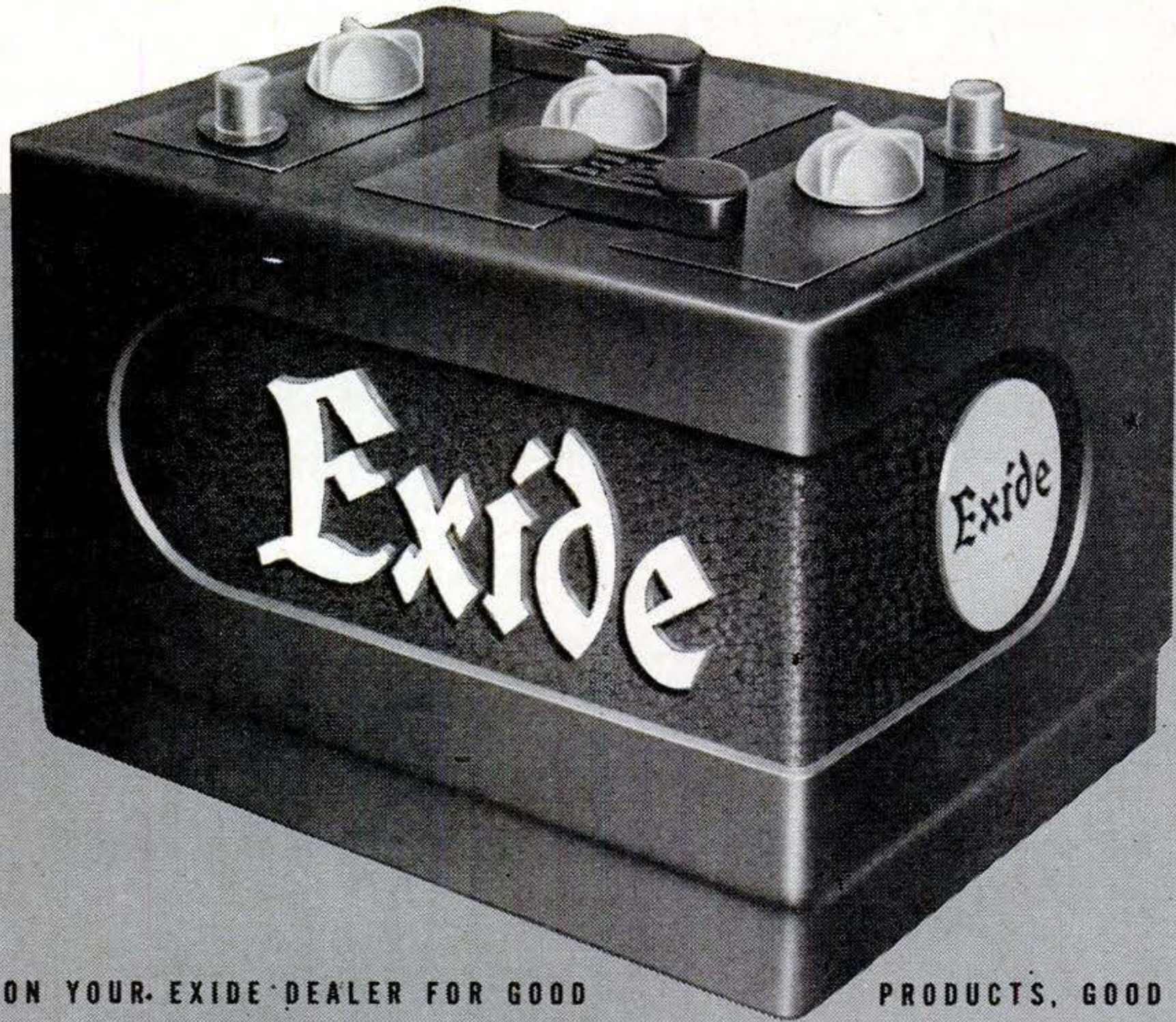

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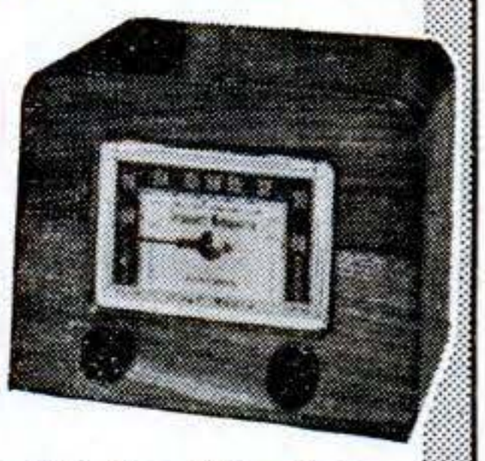

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Hex	½"	⅜"	5/16"
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Thread Length	7/32	7/32	5/32
Weight, Grams	8	3½	2½

Champion Spark Plugs for model gas engines give the same dependable performance as regular Champions. Champion Ceramic insulation—Sillment sealed. Alloy needlepoint electrodes for easy starting. One piece construction.

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FOLLOW THE EXPERTS **DEMAND NEW DEPENDABLE CHAMPIONS FOR YOUR CAR**

Listen to the CHAMPION ROLL CALL . . . Harry Wismer's fast sportscast every Friday night, over the ABC network

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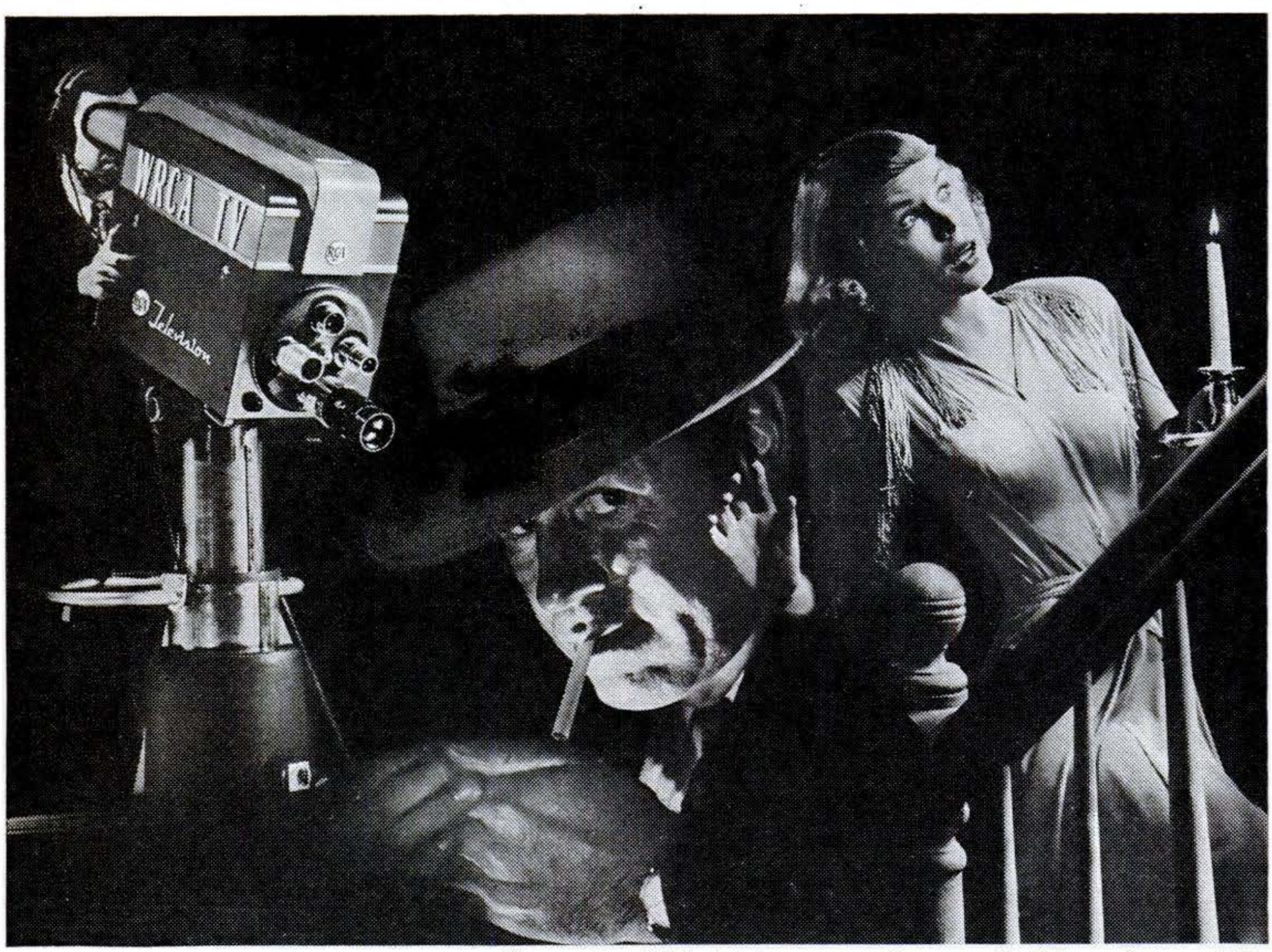


Ultrasensitive RCA television camera tube cuts studio light requirements 90%.

Television finds drama in the dark — with new RCA studio camera

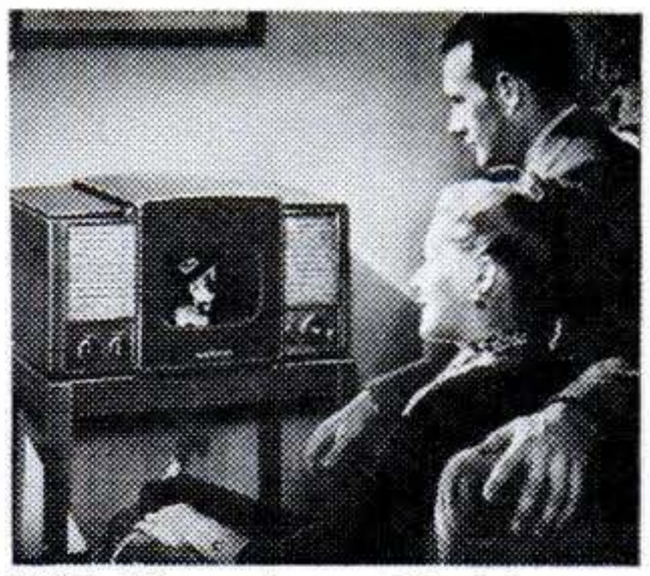
Now television becomes even more exciting as lights are dimmed and the camera reaches deep inside studio shadows to capture action as dramatic as any on stage or screen...

A new studio television camera—developed by RCA scientists and engineers—needs only 1/10th the usual amount of light.

The super-sensitive eye of the new camera is an improved Image Orthicon Tube...of the type once used only outdoors. With it, studio broadcasts are sharper, clearer—and since so very little illumination is needed, heat in the studio is reduced to a minimum. No more blazing lights!

Such improvements come regularly from research at RCA Laboratories, and apply to all branches of radio, television, electronics, and recording. These up-to-the-minute improvements are part of your purchase of any product bearing the name RCA, or RCA Victor.

When in Radio City, New York, be sure to see the radio and electronic wonders at RCA Exhibition Hall, 36 West 49th St. Free admission. *Radio Corporation of America, RCA Building, Radio City, New York 20, New York.*



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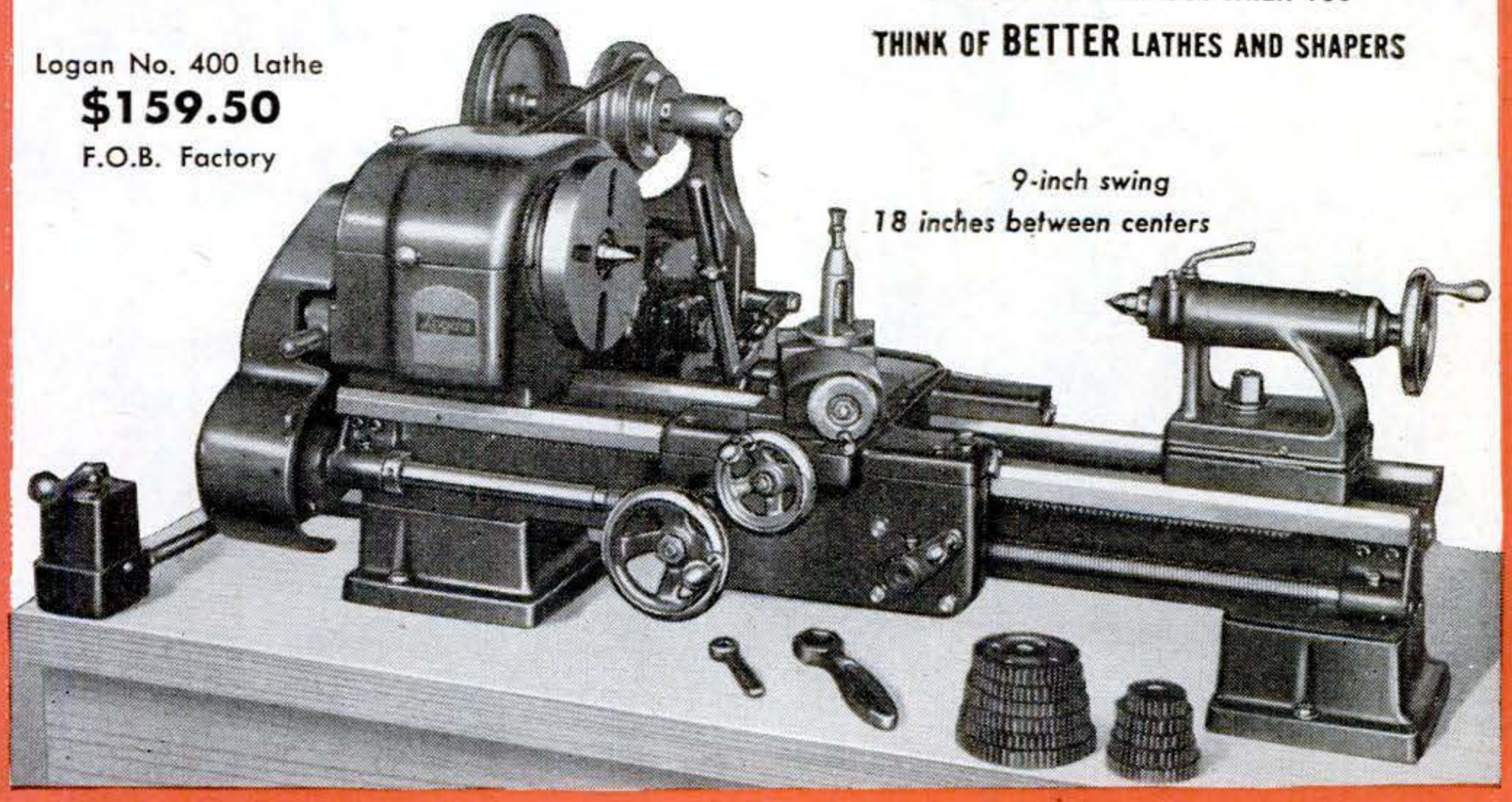

NEW 9-inch Logan Lathe

Logan performance In a New Size At a New Low Price

Here is something *new* in 9-inch lathes . . . Logan advanced design, accuracy, ruggedness, and all-around dependability built in a 9-inch size. The Logan 9-inch Lathe has all the basic features that have made larger Logan Lathes outstanding industrial performers. The spindle turns on ball bearing mountings inherently well adapted to high speed work. The two V-ways and two flat ways of the rugged bed are precision ground to within .0005" of parallelism. Massive construction insures steadiness on heavy cuts and durability. Self lubricating bronze bearings protect vital wear points. The result is a versatile lathe with the traditional Logan sustained accuracy, effective in precision manufacturing operations, general machine shop and tool room work, auto, and appliance repair, and for home workshop use. Complete information is available at your Logan Lathe dealer's, or on written request.

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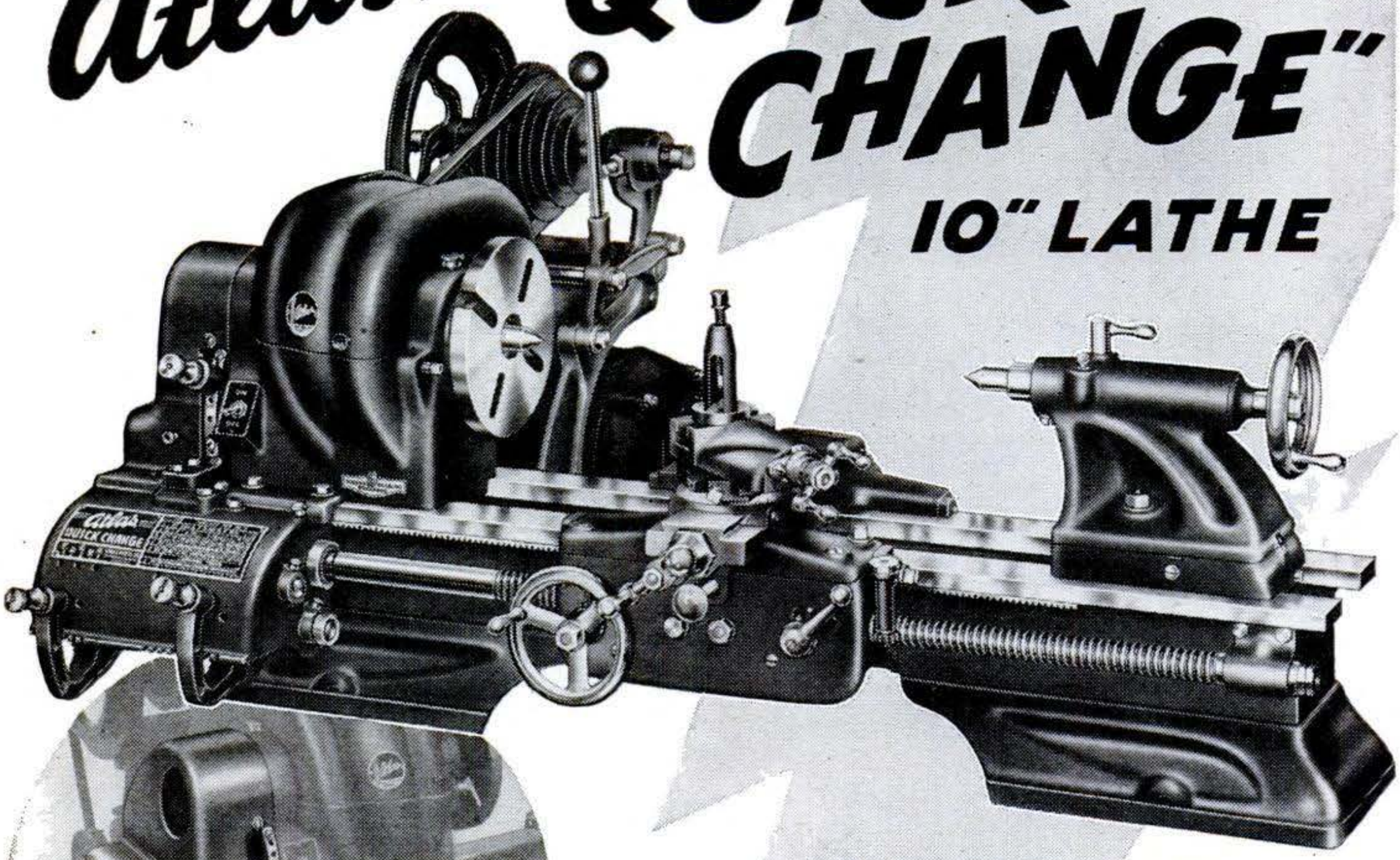
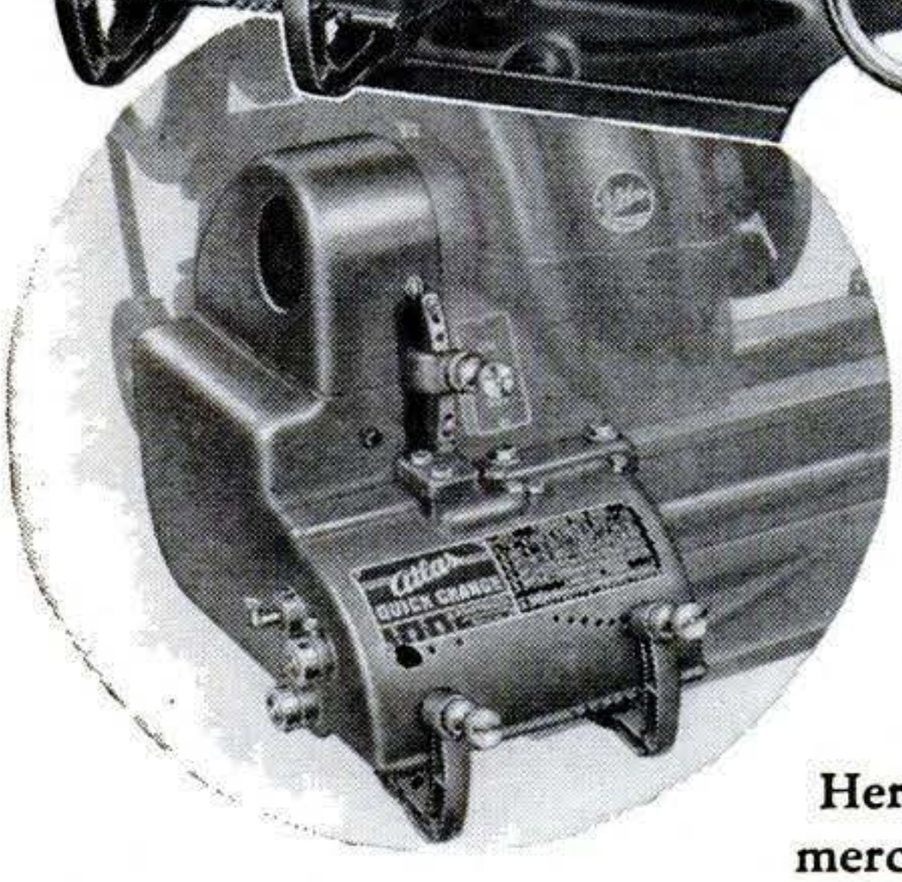
ANNOUNCING THE NEW Atlas "QUICK-CHANGE" 10" LATHE





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(QUICK-CHANGE UNIT ADAPTABLE TO ANY ATLAS 10" LATHE)

Here's new lathe efficiency for your home or commercial shop! The new Atlas Quick-Change gives you instant fingertip selection of 54 threads or feeds ... speeds every turning operation requiring the use of power feed ... saves you many hours of set-up time. Quick-Change does not limit the odd thread and feed capacity of the Atlas lathe. Hundreds of additional threads and feeds are obtained with standard Atlas change gears, extra — for metric threading, special tooling, coil and wire winding, etc. Other outstanding Atlas features include 16 spindle speeds; precision ground bed; Timken tapered roller bearings; back gears; complete V-belt drive; reversible automatic power cross and longitudinal feeds. New illustrated Quick-Change bulletin gives you full details. Send a postcard for your copy.

Model QC 42 (above) 24" between centers $250.00

Also QC 54 — 36" between centers ... $280.00

Prices less motor F.O.B. Kalamazoo

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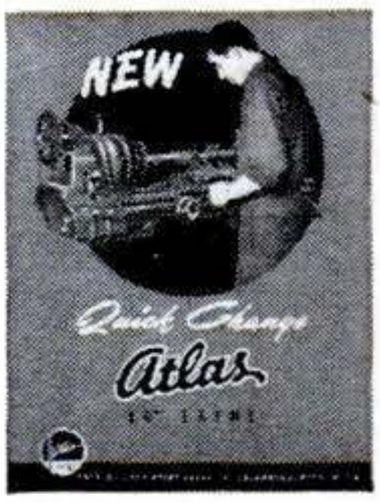

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After cleaning out the radiator, you can keep it free from rust all season by pouring in a can of DU PONT ACID AND RUST INHIBITOR. This neutralizes the acid and prevents damaging rust from forming.

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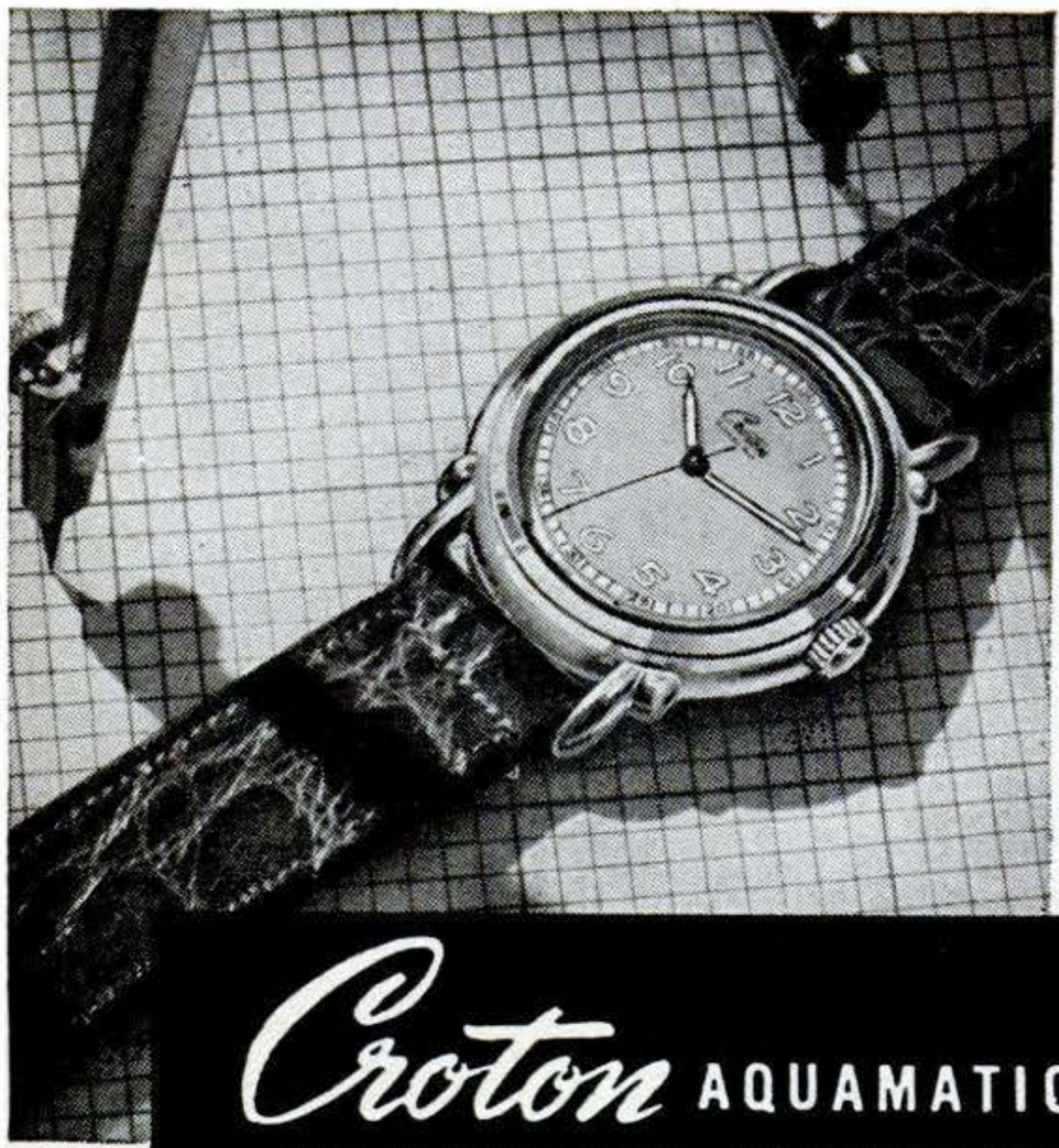

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* 3 Aquamatics were tested against the average of 9 famous watches wound by hand, in a 30-day wearing test by a leading laboratory. Aquamatic proved 13.5% more accurate! Write for free booklet. Croton Watch Co., Inc., 48 W. 48th St., N. Y. 19.

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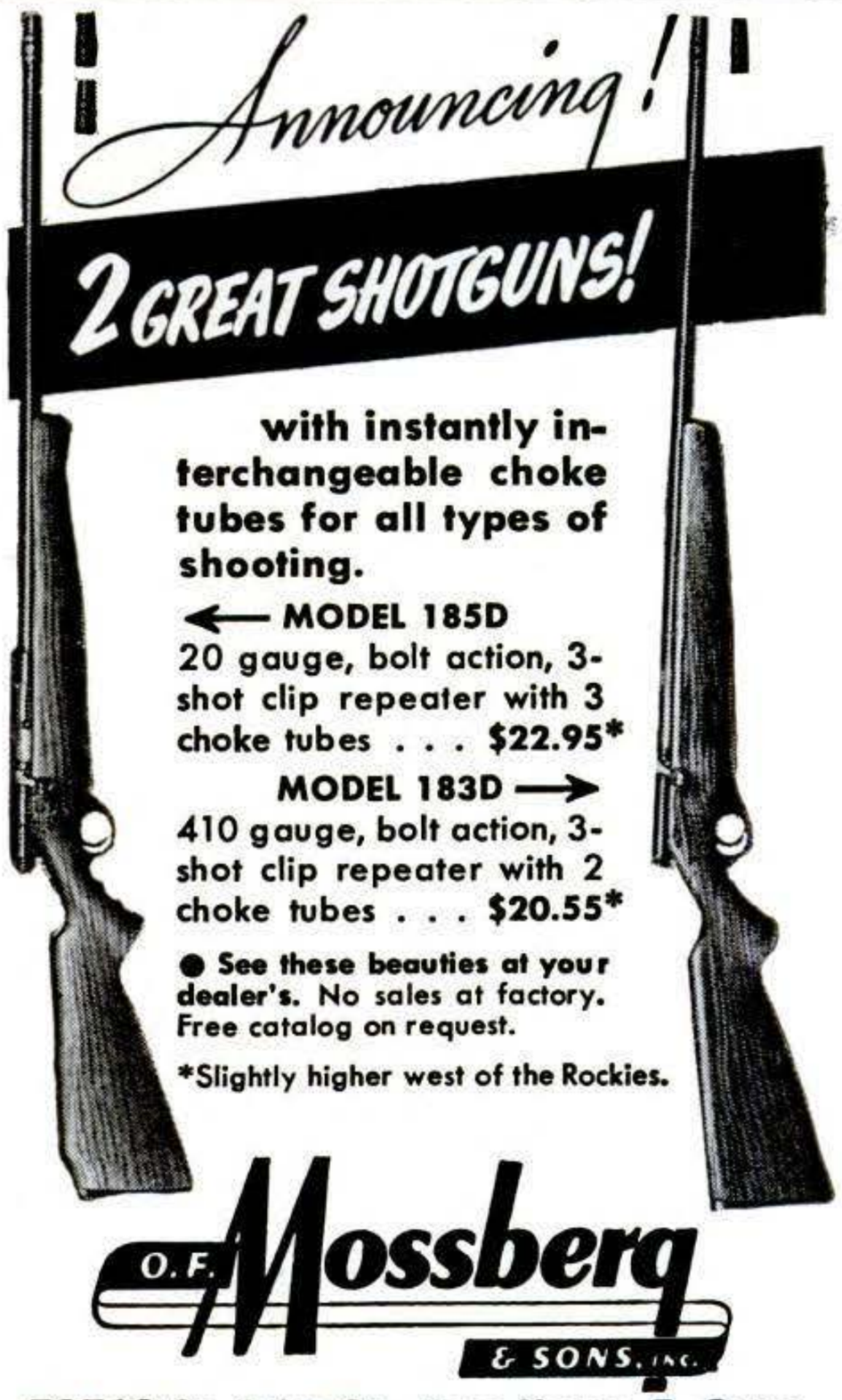

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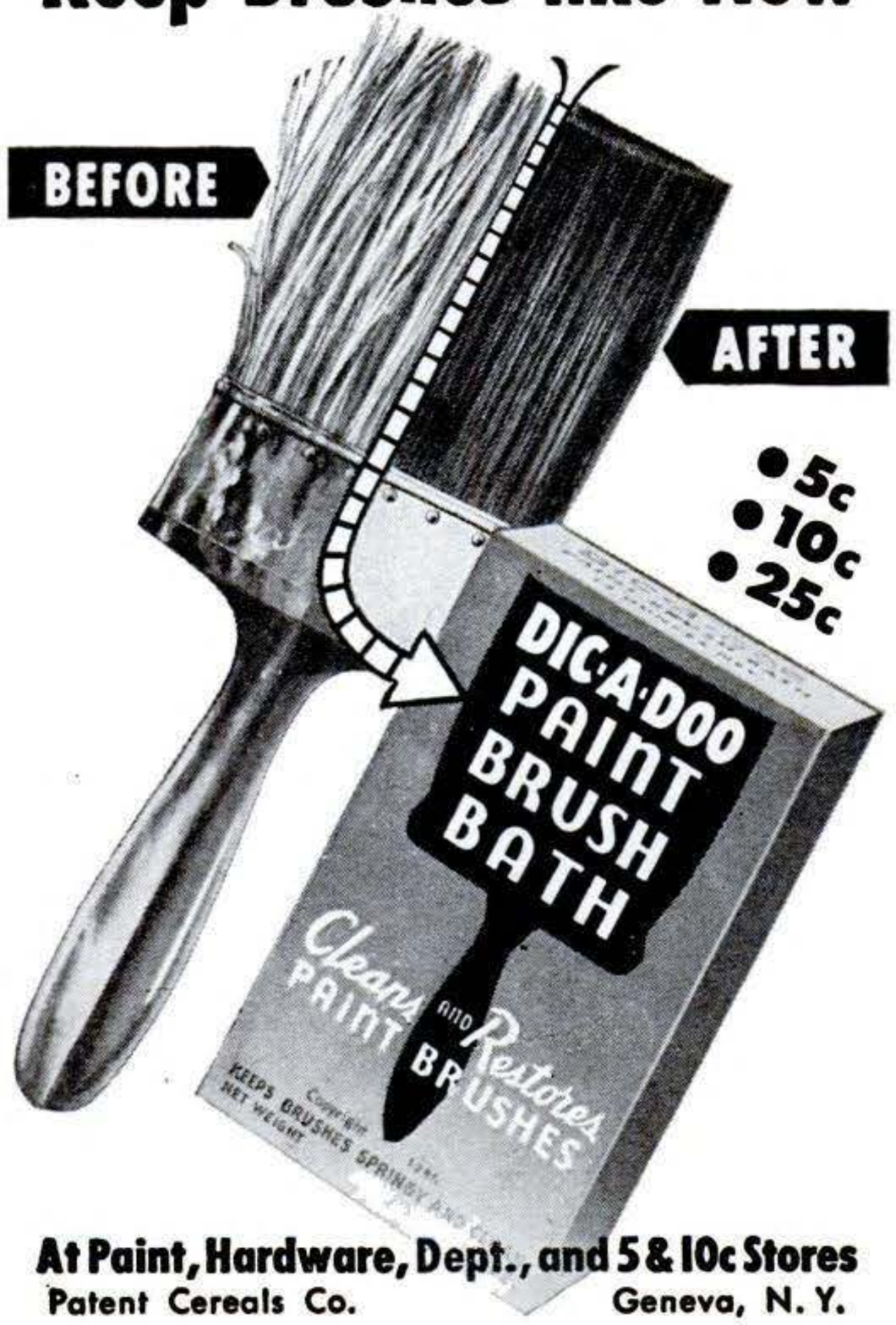

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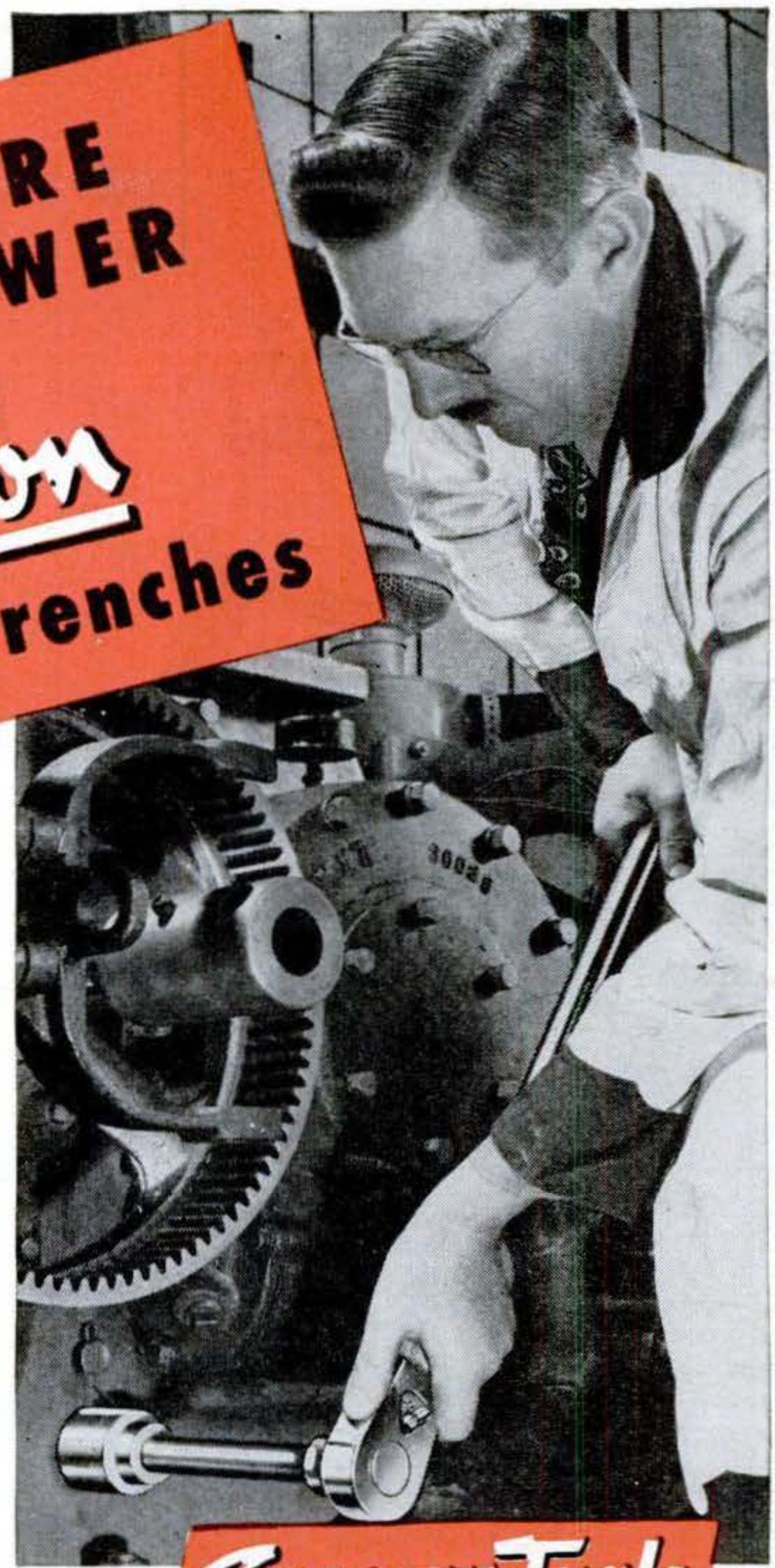

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Snap-on combinations, like the one illustrated above, are highly versatile tools and can be used on dozens of tough nut-turning operations throughout the plant.

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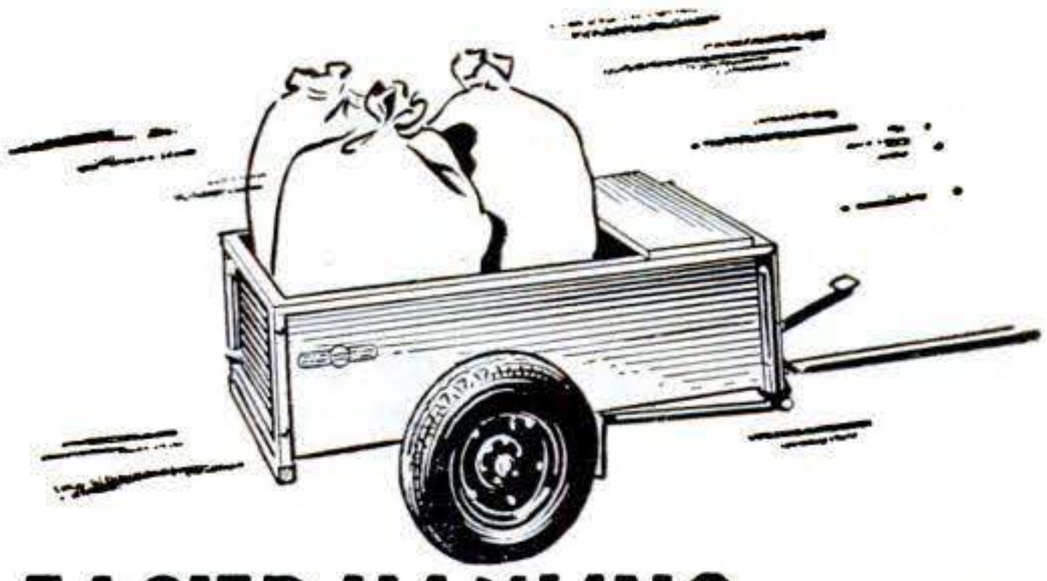

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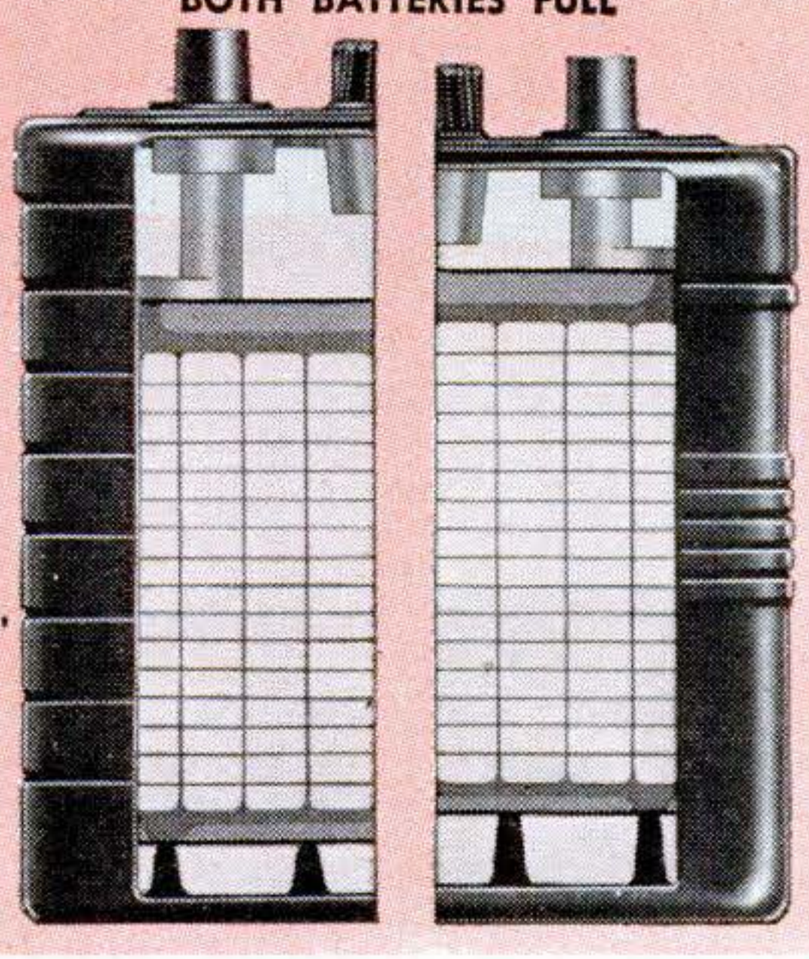
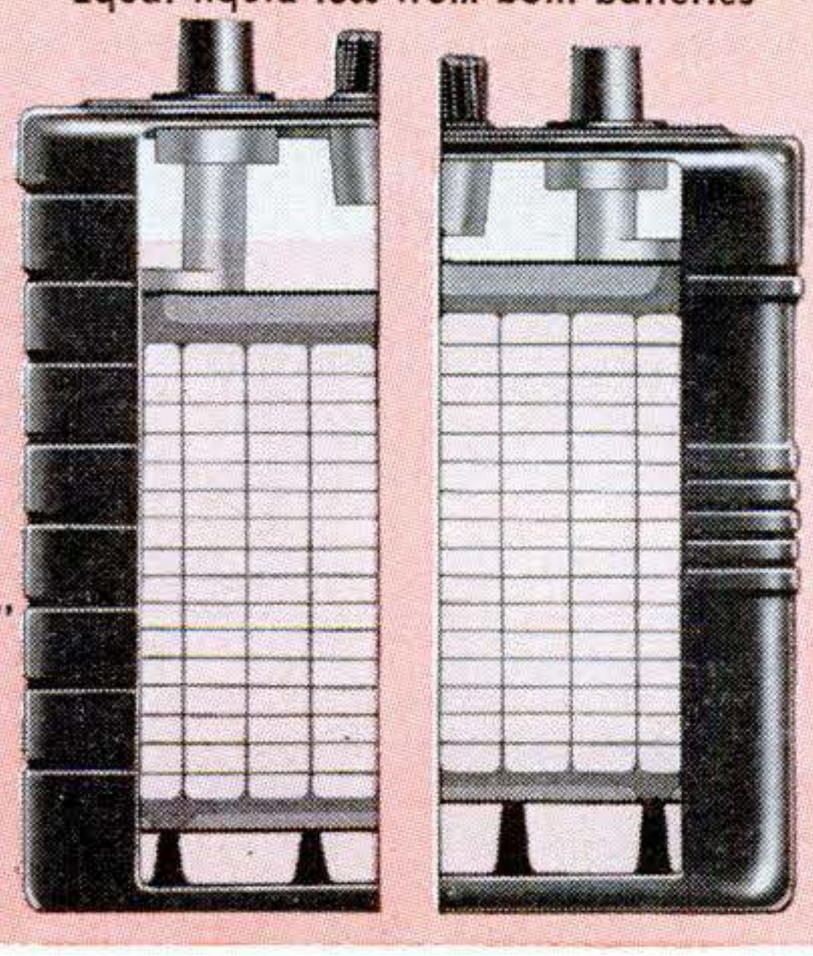


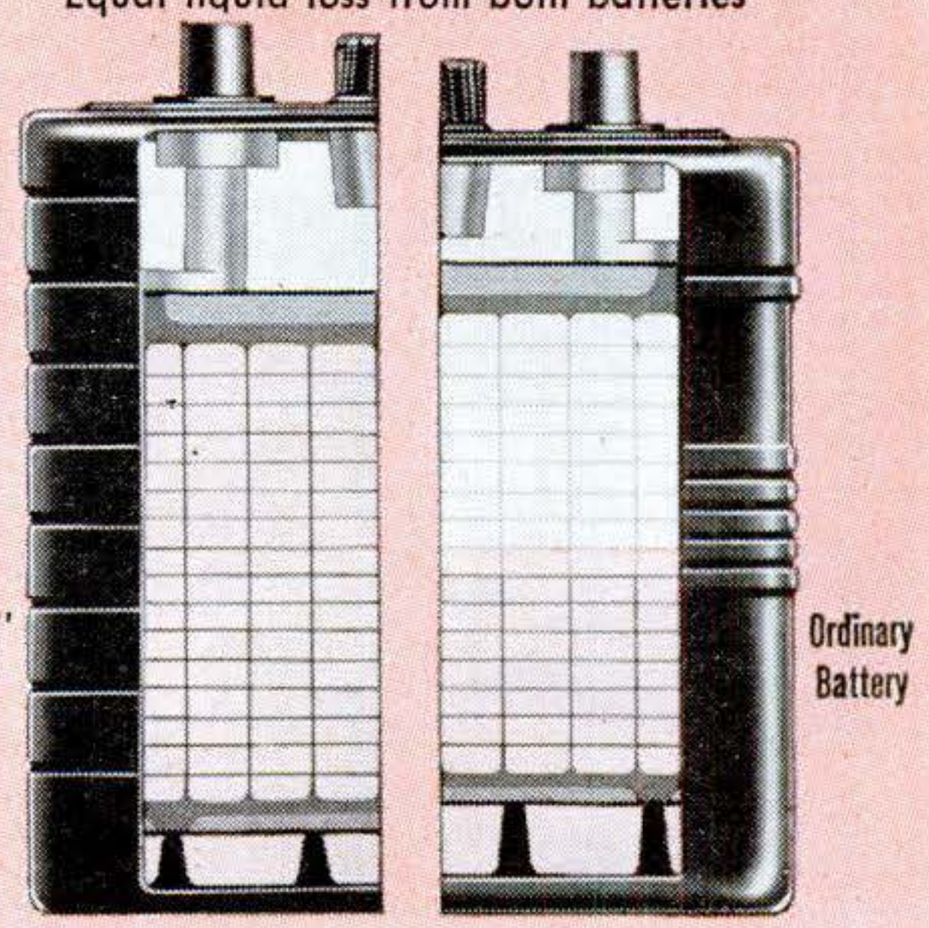
2

FIRST STAGE OF EVAPORATION
Equal liquid loss from both batteries



3

ADVANCED STAGE OF EVAPORATION
Equal liquid loss from both batteries



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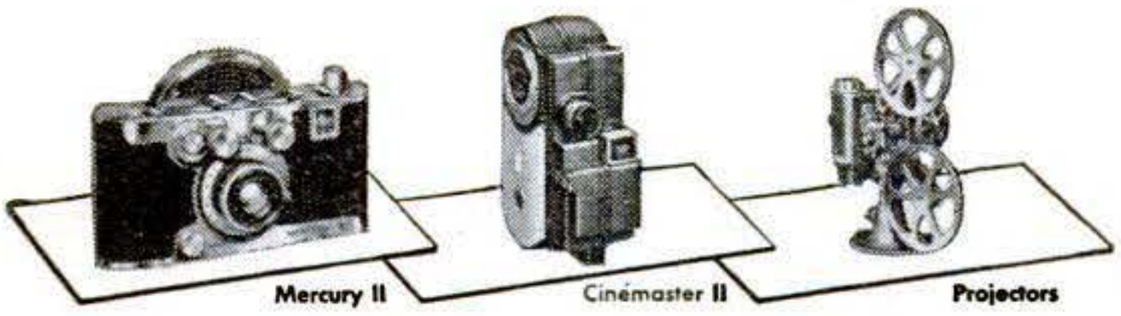

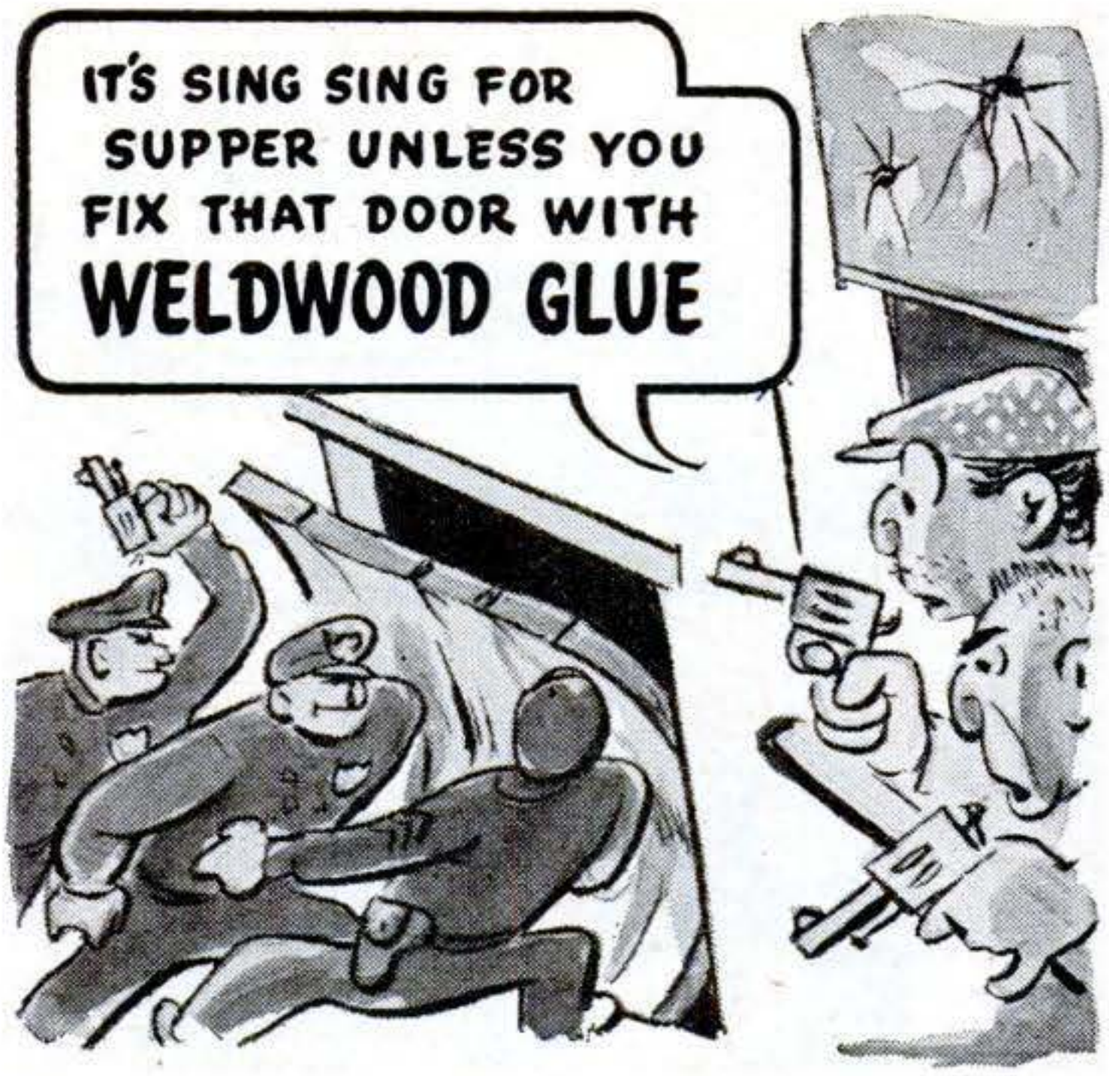

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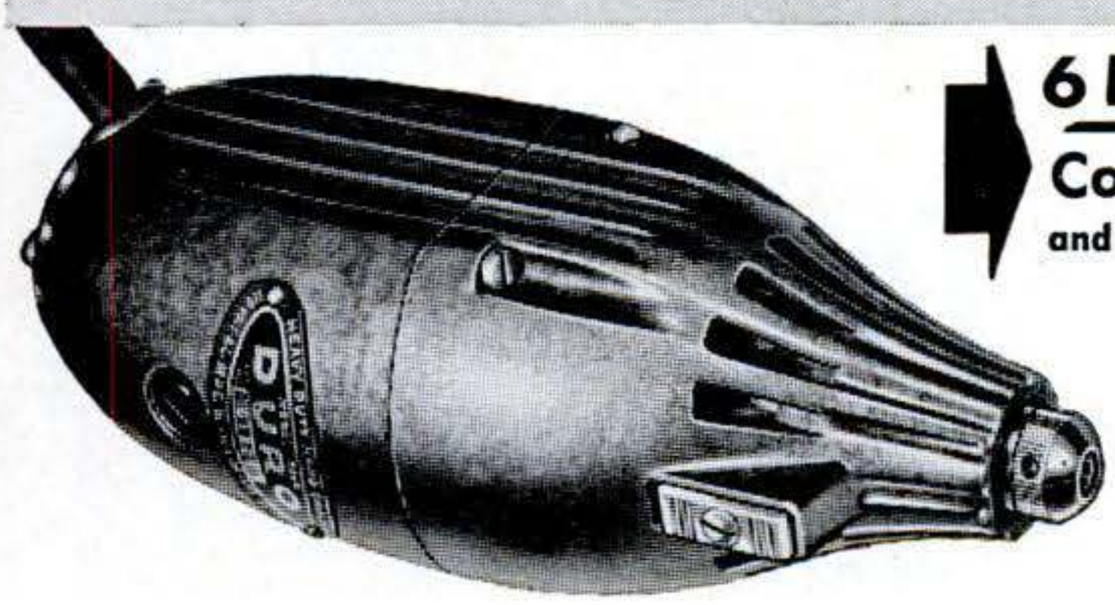

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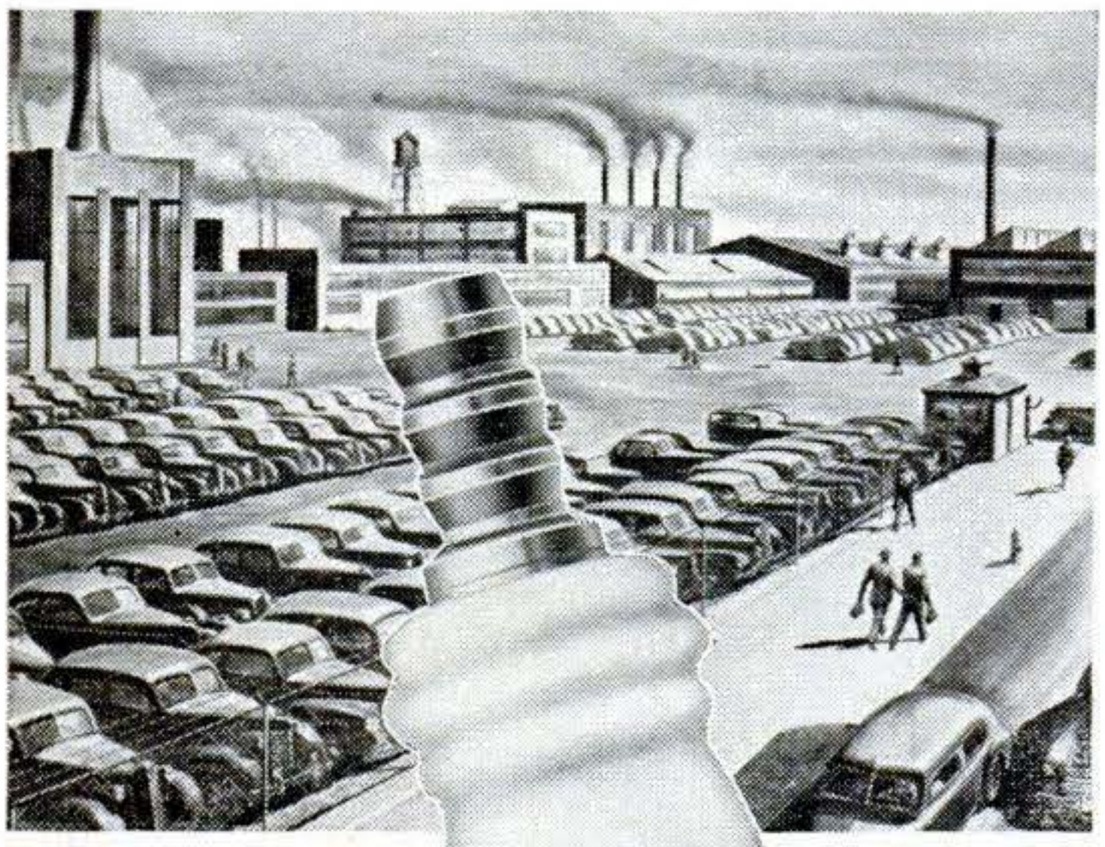

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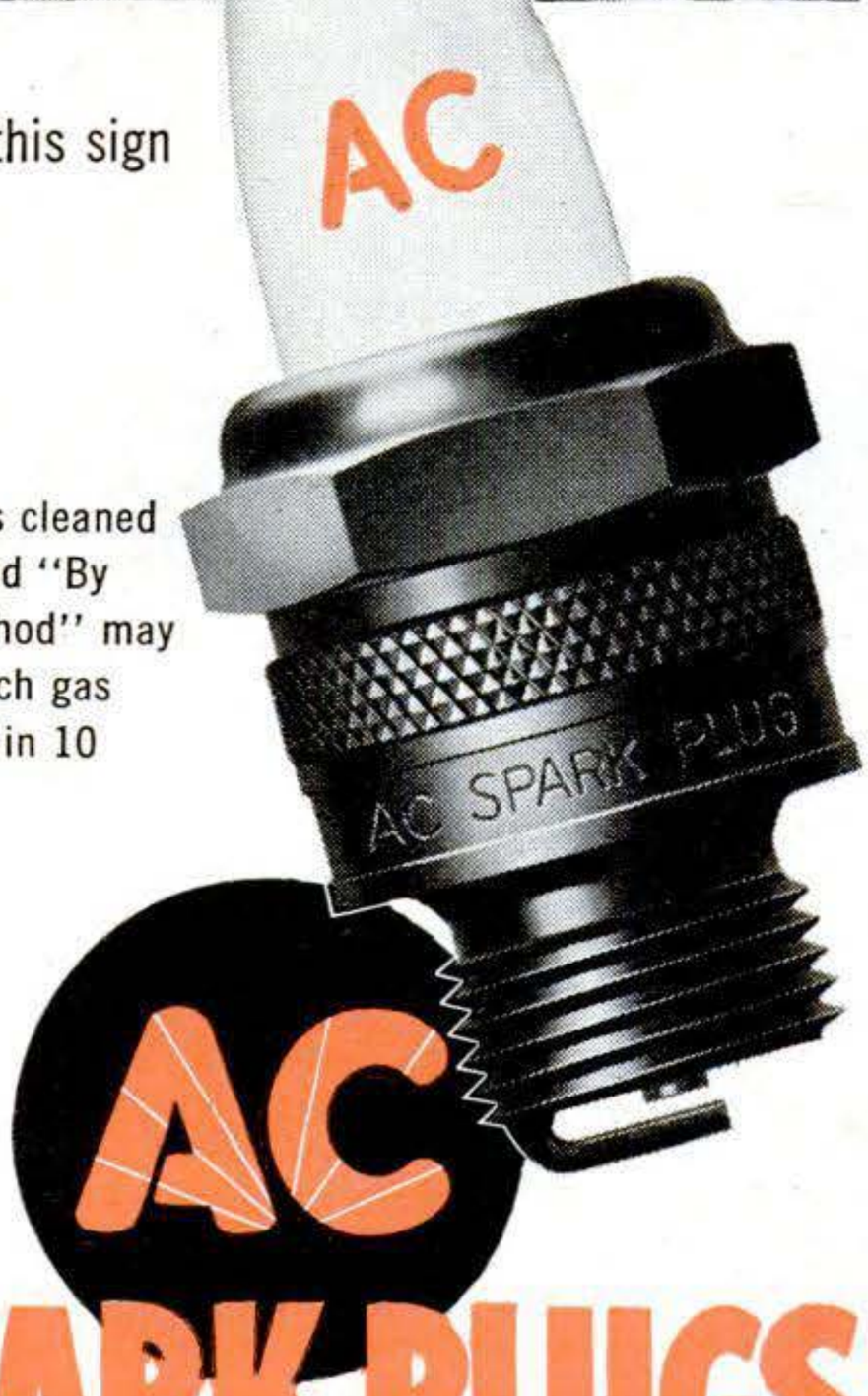

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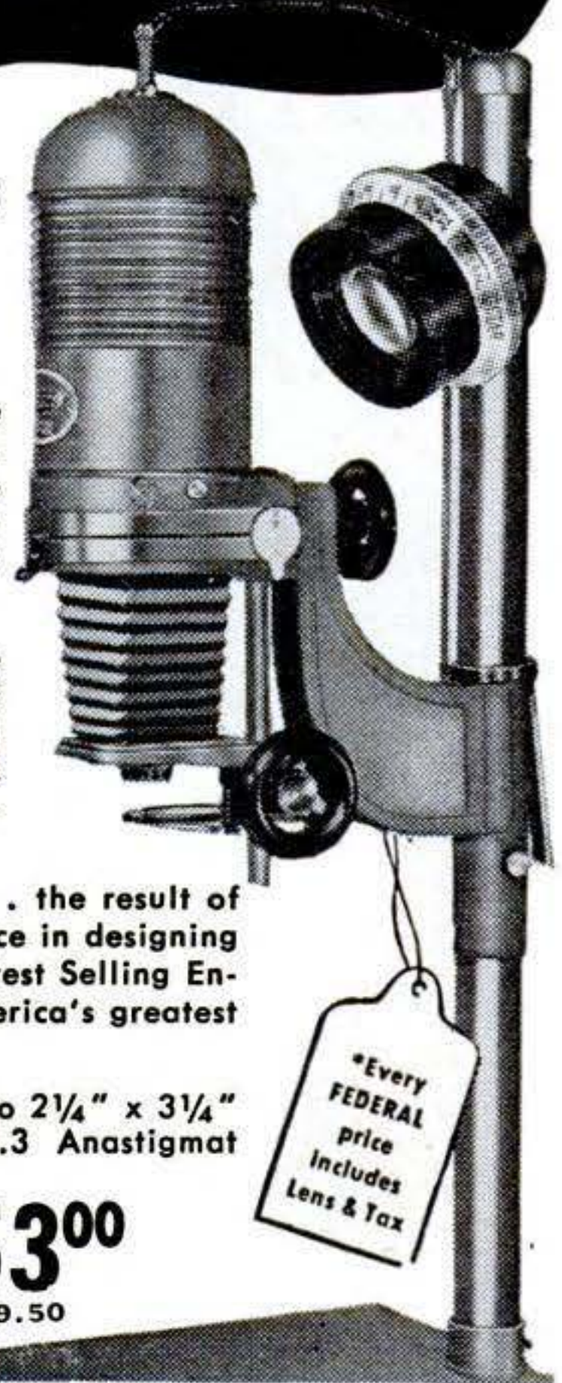

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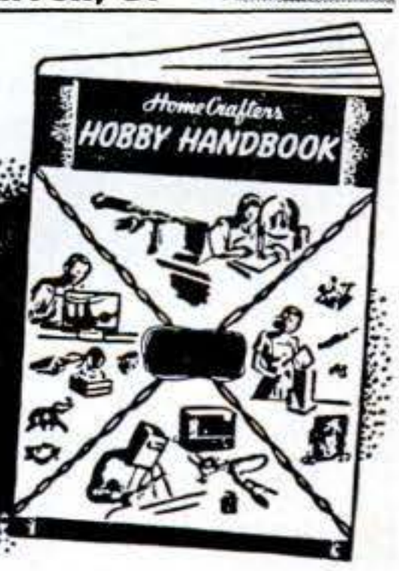

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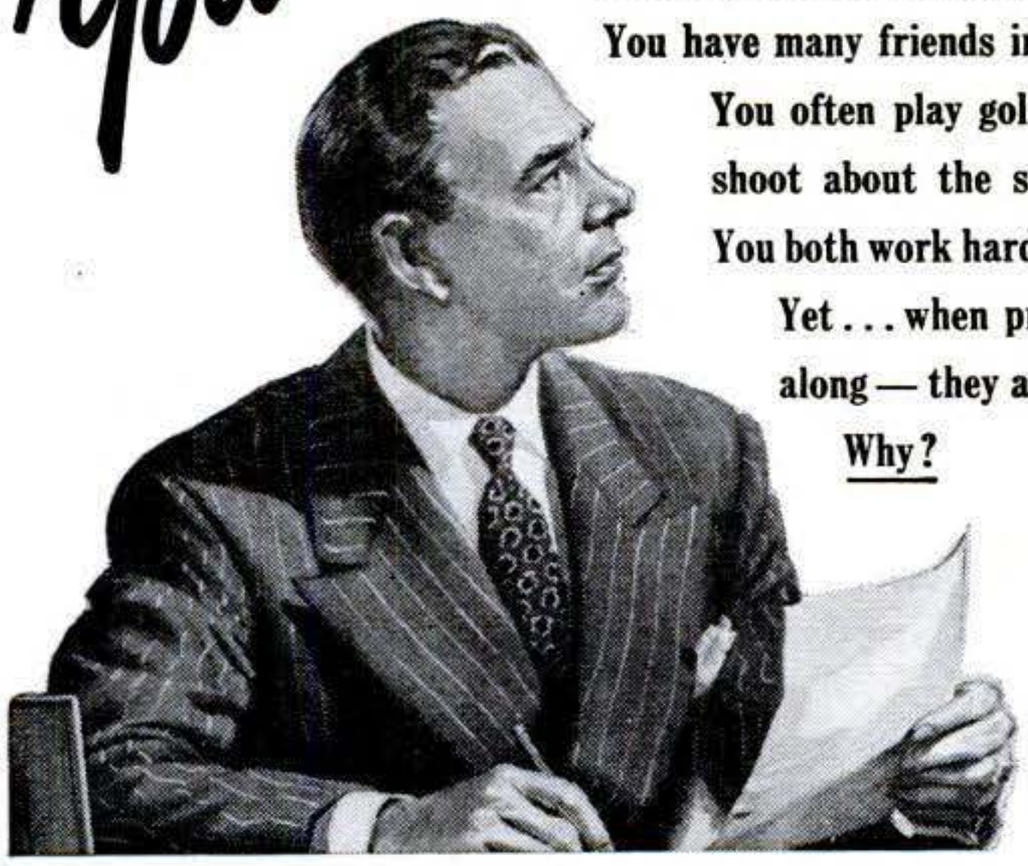

You're just as smart as Bill . . .
You have many friends in common . . .
You often play golf together (and shoot about the same game) . . .
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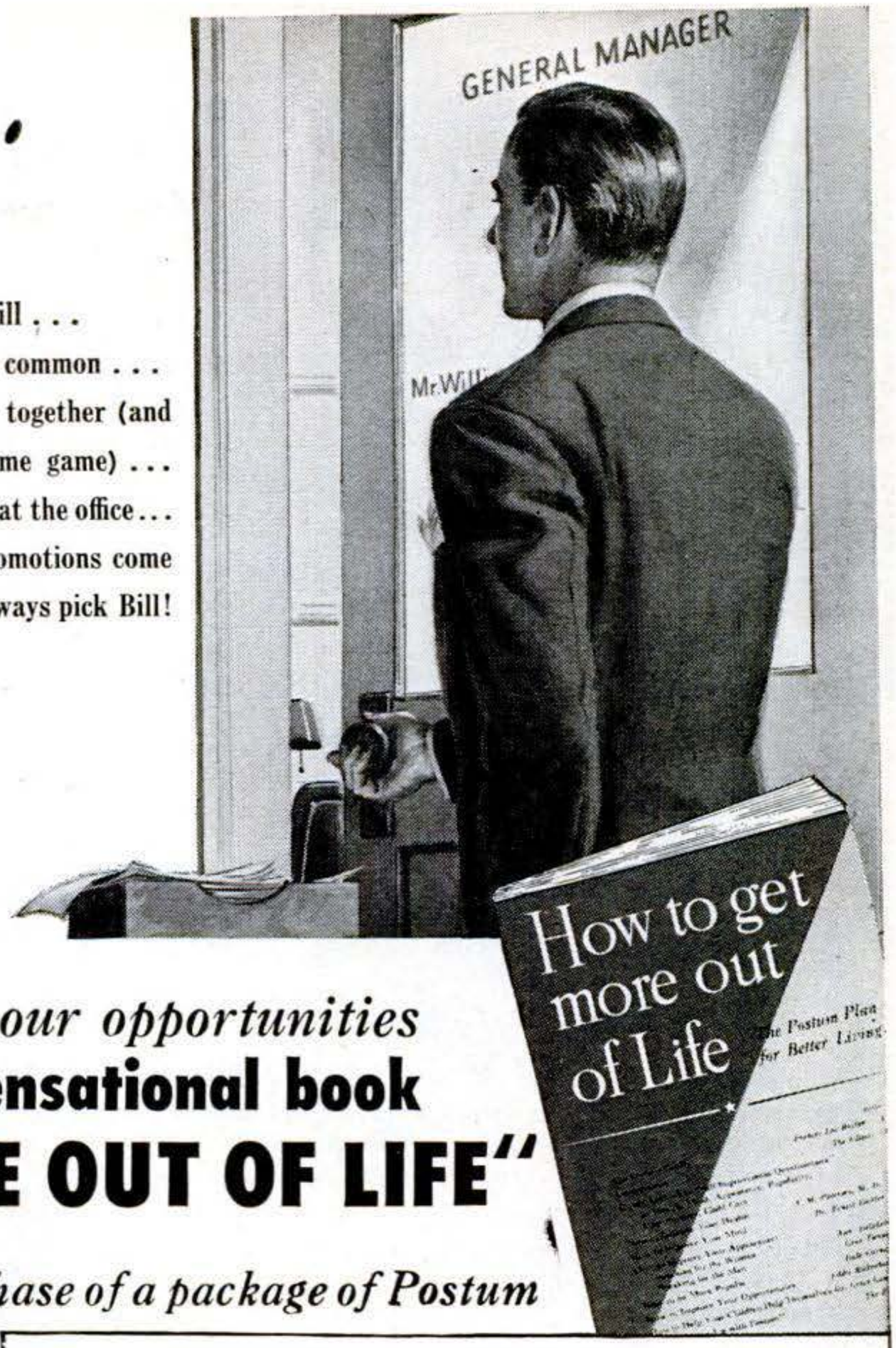
Yet . . . when promotions come along — they always pick Bill!
Why?



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Low temperature . . . electrical and mechanical design for low-temperature operation. Ventilated open type. 40° C. Rise.

Laminated steel rotor . . . carefully ground and balanced for maximum efficiency.

Centrifugal starting switch . . . built for trouble-free operation.

High-grade ball bearings . . . sealed against dust and grit, give smooth performance and long wear.

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THE HOOVER COMPANY
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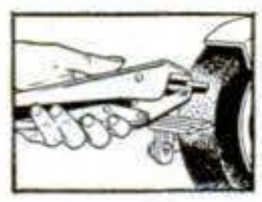
A GIANT IN YOUR HAND! **NEW!**



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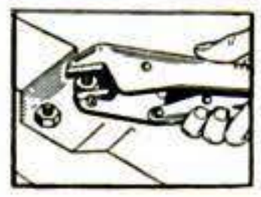

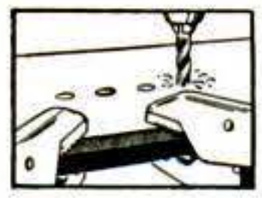

Serves as a plier or wrench—or jaws can be quickly locked tight, so that hand pressure can be released and tool used as a hand vise or clamp. PARALLEL-UNIVERSAL JAWS afford *full grip* on either straight or angular objects. Terrific grip; any object held in jaws can not slip or be twisted loose! Pressed steel body, hardened (replaceable) jaws. *Guaranteed.* 10" size, $2.25; 7", $1.75. If not yet at your dealer's, order from us but give his name.

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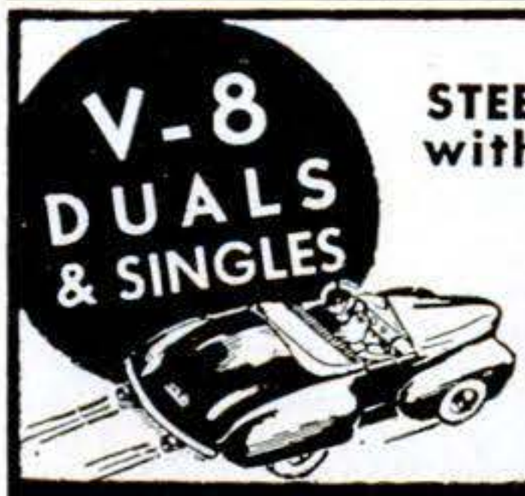

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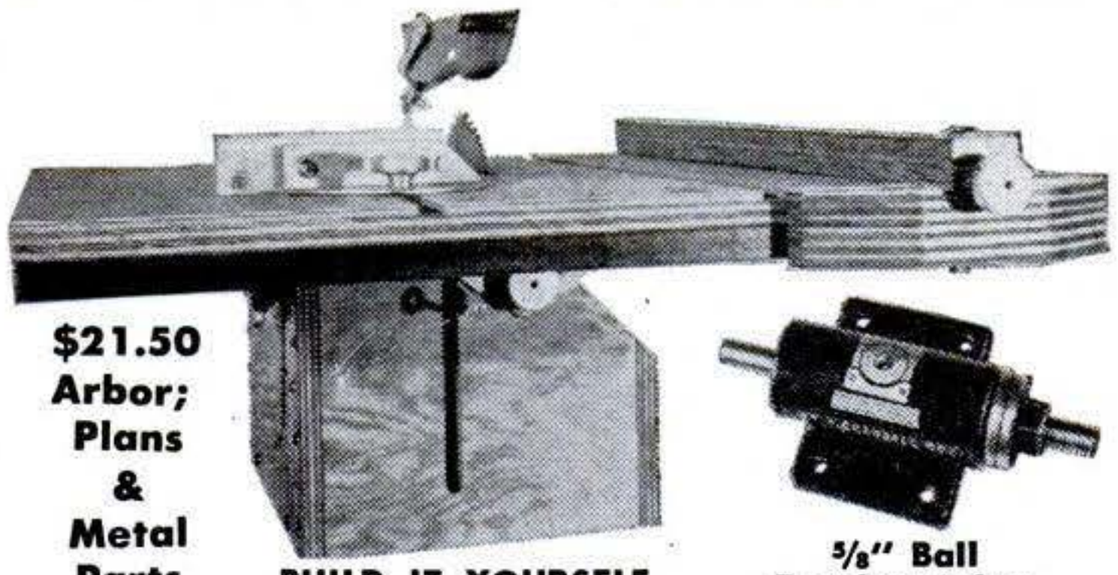

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5/8" Ball Bearing Arbor

In your own shop—with our Ball-bearing Arbor, Plans and Metal Parts. Here's the saw you've been wanting for your shop!

With our easy to follow step-by-step plans and instructions, you can build it with ordinary hand tools for a fraction the cost of all metal saws of comparable size and capacity. Sturdy wood, steel and aluminum construction.

FEATURES—

Big roomy top 27" x 32" with 13½" clearance ahead of saw. Tilts to 45°.

Precision built ball-bearing arbor lubricated and sealed. No further lubrication required.

Self aligning, full length rip fence. Indexed mitre gauge. Indexed table tilting quadrant. Adjustable saw arm—cuts from 0" to 2¼".

COMPLETE KIT— Includes Ball-bearing Arbor with Saw Plans and instructions, and all metal parts, bolts, washers and screws (less saw blade) **$21.50**

5/8" Ball-bearing Arbor only—with Saw Plans and instructions . . . . . **$ 6.95**

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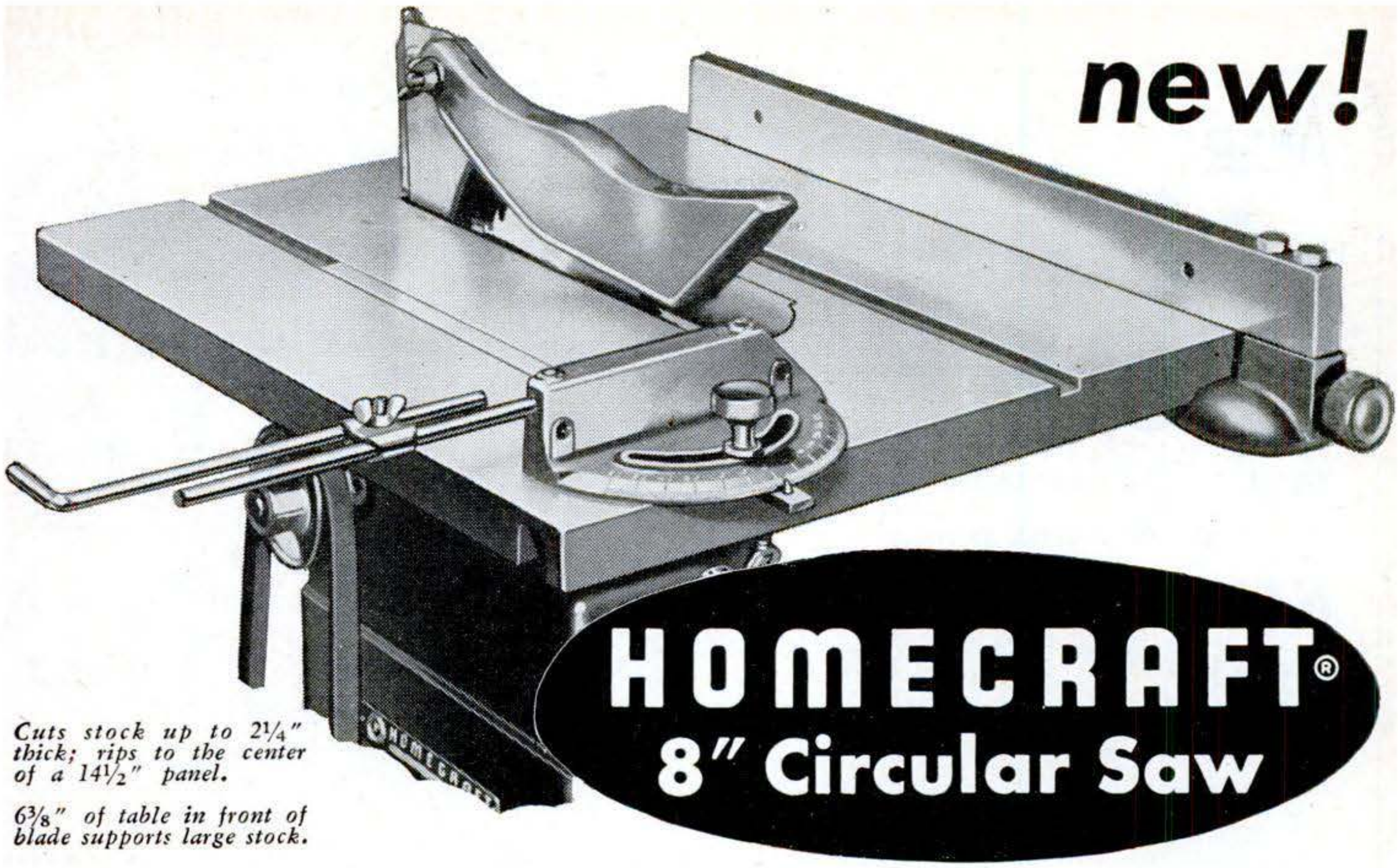

Cuts stock up to 2¼" thick; rips to the center of a 14½" panel.

6⅜" of table in front of blade supports large stock.

Only $34.95 for this Dependable Saw

Built Expressly for the Hobbyist!

Answers the demand for a moderate-priced tool that delivers all-around satisfaction

The 8-inch saw blade gives you plenty of big cutting capacity.

Swing guard, splitter, and anti-kickback fingers provide safety.

Rip fence locks securely in any position on table.

Table tilts 45° to right; firmly locks in place.

Convenient ball-crank handle quickly raises or lowers table.

Miter gauge provides accurate angles of cut — either side of blade.

This good-looking, versatile *Homecraft* Circular Saw is made especially for folks who enjoy the fun and healthful recreation of "puttering around" with woodworking.

With this practical tool, you can rip and cross-cut . . . make mouldings . . . cut mitres and curves . . . do drawer-joint work, rabbeting, etc.

Built by the Maker of Quality Tools

Behind the *Homecraft* Circular Saw is the engineering skill of the men who make Delta Power Tools — the famous top-notch tools that practically every woodworking enthusiast dreams of owning some day.

In schools and factories, as well as home shops, Delta tools have long been recognized as outstanding, for safety, accuracy, and dependability.

A Lot of Saw for the Money!

With the *Homecraft* Circular Saw, Delta meets the long-standing need for a really good, popular-priced tool that is exactly suited to the intermittent use the average hobbyist gives a machine.

Delta engineers have included features that make it just as fine a saw as can possibly be built for its moderate price:

Precision-Ground Steel Arbor — has accurately-cut threads to hold the saw blade, as well as a moulding cutterhead and a dado head up to 13/16" wide.

The arbor runs in oil-impregnated bearings that are constantly wick-lubricated.

Tilting Table — swings on two heavy cast-iron trunnions. A tilt scale indicates the amount of angle in your cut.

Solid-Steel Rip Fence — slides to any position across the table and can be used on either side of the blade.

See It At Your Dealer!

Ask your *Homecraft* dealer to show you this circular saw, and his complete display of *Homecraft* Power Tools that range in price from $29.95 to $39.95.

See if you don't agree that you can enjoy a lot of pride and satisfaction working with the reliable *Homecraft* Circular Saw.

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Sure . . . he knows how your nerves jangle . . . while your eyes strain through that ghost-like film that grows on your windshield. He knows how that film blurs dangerously under your windshield wiper in the next storm. He has tried hard to clear it . . . to please you . . . using the best he has had . . . up to now . . . to work with. Maybe your gas man is discouraged . . . hasn't seen ANCO Speed Pad . . . thinks FILM can't be whipped . . . quickly and completely. You can't blame him for that.

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Yes . . . he can get . . . from his ANCO distributor . . . an extra ANCO Speed Pad . . . for your own convenient use . . . in cleaning your windshield . . . or your windows and mirrors at home. And he can equip your windshield . . . quickly . . . NOW . . . with keen new ANCO Wiper Blades and Arms . . . to KEEP that windshield CLEAN . . . in storms ahead. Get yours today!

May save you a costly smashup!

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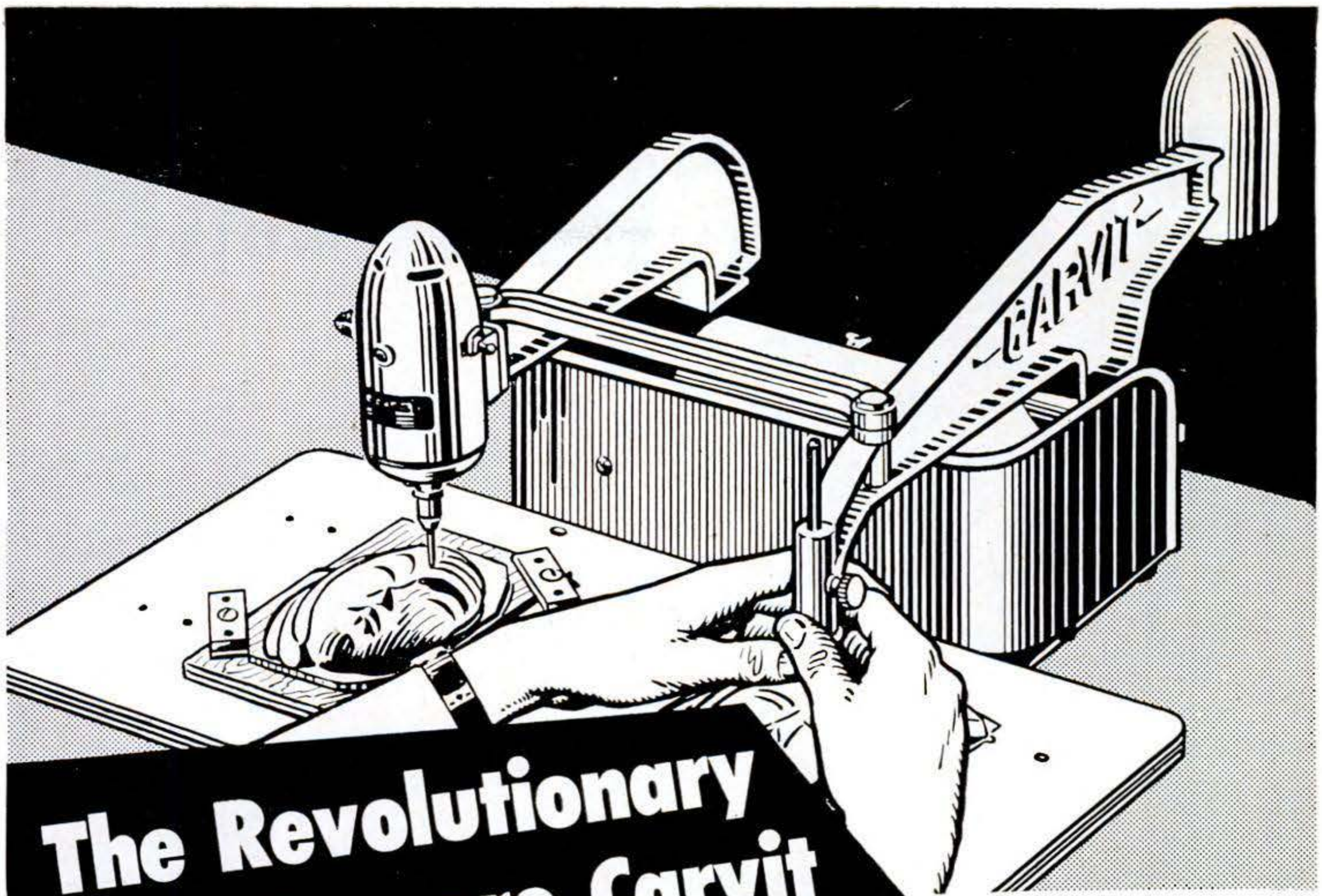

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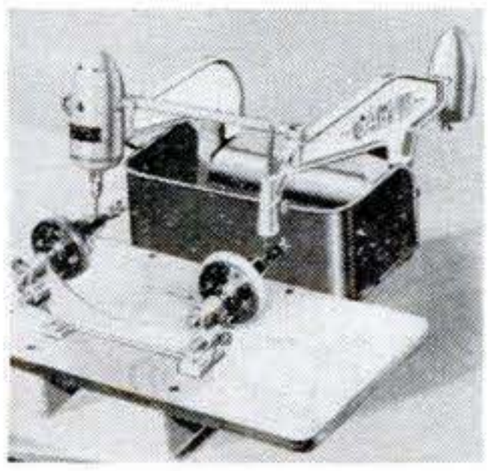
makes you a skilled wood-carver in 20 minutes!

No skill or training needed to do work like this

Carve useful ornaments for the home — distinctive gifts — fine carvings that *sell!*

Here's a fascinating new hobby — complete in one tool. Making fine wood carvings with the Carvit is so simple a child can do it! The unbelievable perfection of your first carving amazes your friends! Experienced craftsmen use the Carvit to give their woodworking projects that *real* professional touch.

With the Carvit, you make beautiful replicas of inexpensive objects you can find in any dime store or gift shop — reproducing them in mahogany, walnut, and other fine woods. Your carvings are many times more beautiful and valuable than your original models!



With an index attachment, the Carvit reproduces objects in the round — statuettes, and busts.

You're an expert at once — with a Carvit!

Here's how the easy-to-use Carvit works: You clamp a model to the table below the tracer, and a wood block below the cutter. Then you switch on the motor and guide the tracer over the raised contours of your model. The cutter moves with the tracer to carve an exact duplicate of the model.

Carving with the Carvit is fascinating fun for everyone. The Carvit is *the ideal gift for your sweetheart, husband, or son!* See the Carvit at your local hardware store today — or mail us the coupon below!

Satisfaction guaranteed or your money back in 10 days!

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- ☐ Please send complete information on the Carvit.
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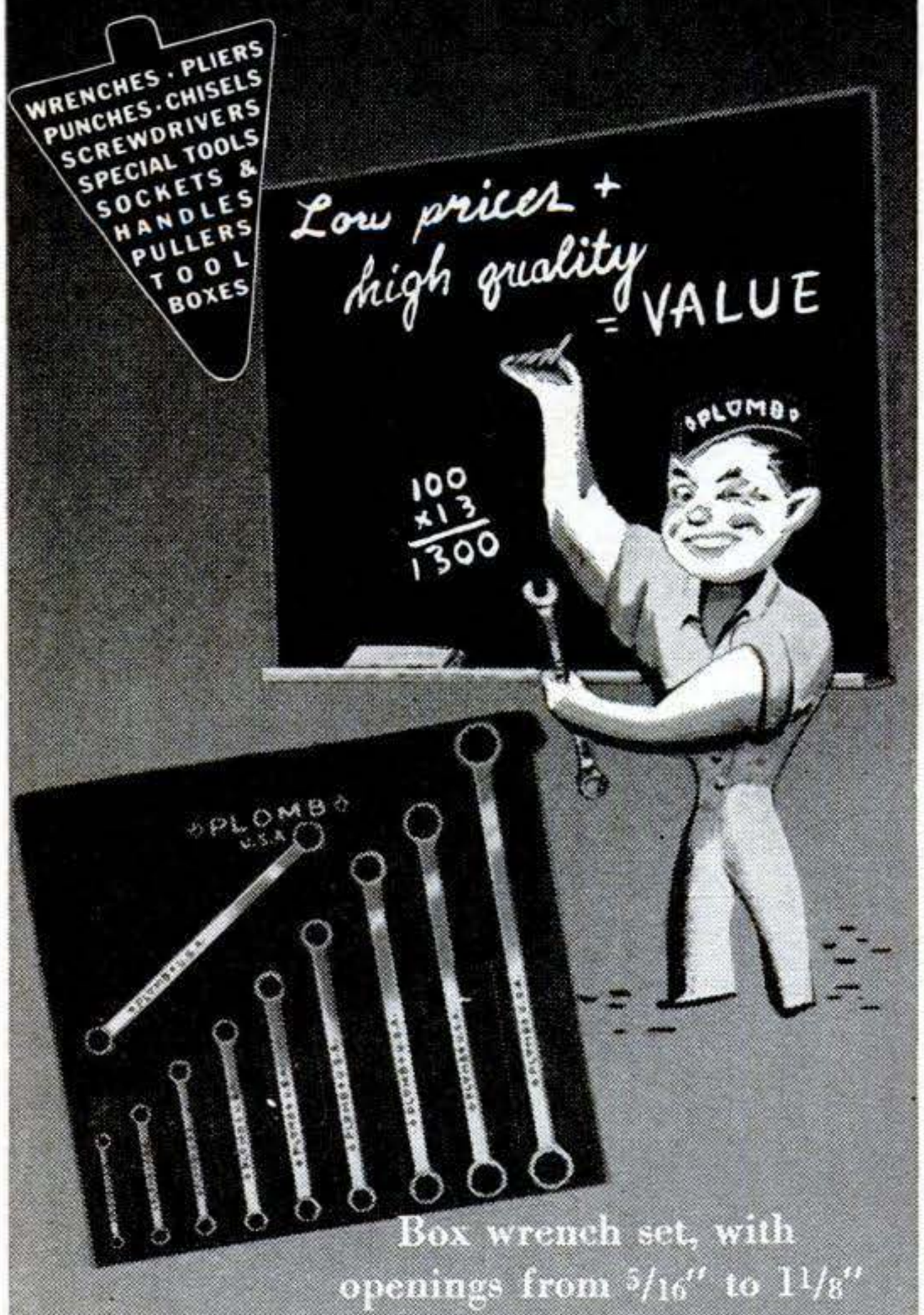

Box wrench set, with openings from 5/16" to 1 1/8"

Today Plomb tools offer you greater value than ever before. Large volume keeps prices low – for higher-quality tools. Don't delay new tool purchases. Get the ones you need for making your set complete from your Plomb dealer, *now!* Write for catalog to Plomb Tool Company, 2257F Santa Fe Ave., Los Angeles 54, Calif.

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Easily lifts or pulls up to 350 pounds. 20 ft. of multi-strand wire rope can be fed out of any one of three drum housing openings.

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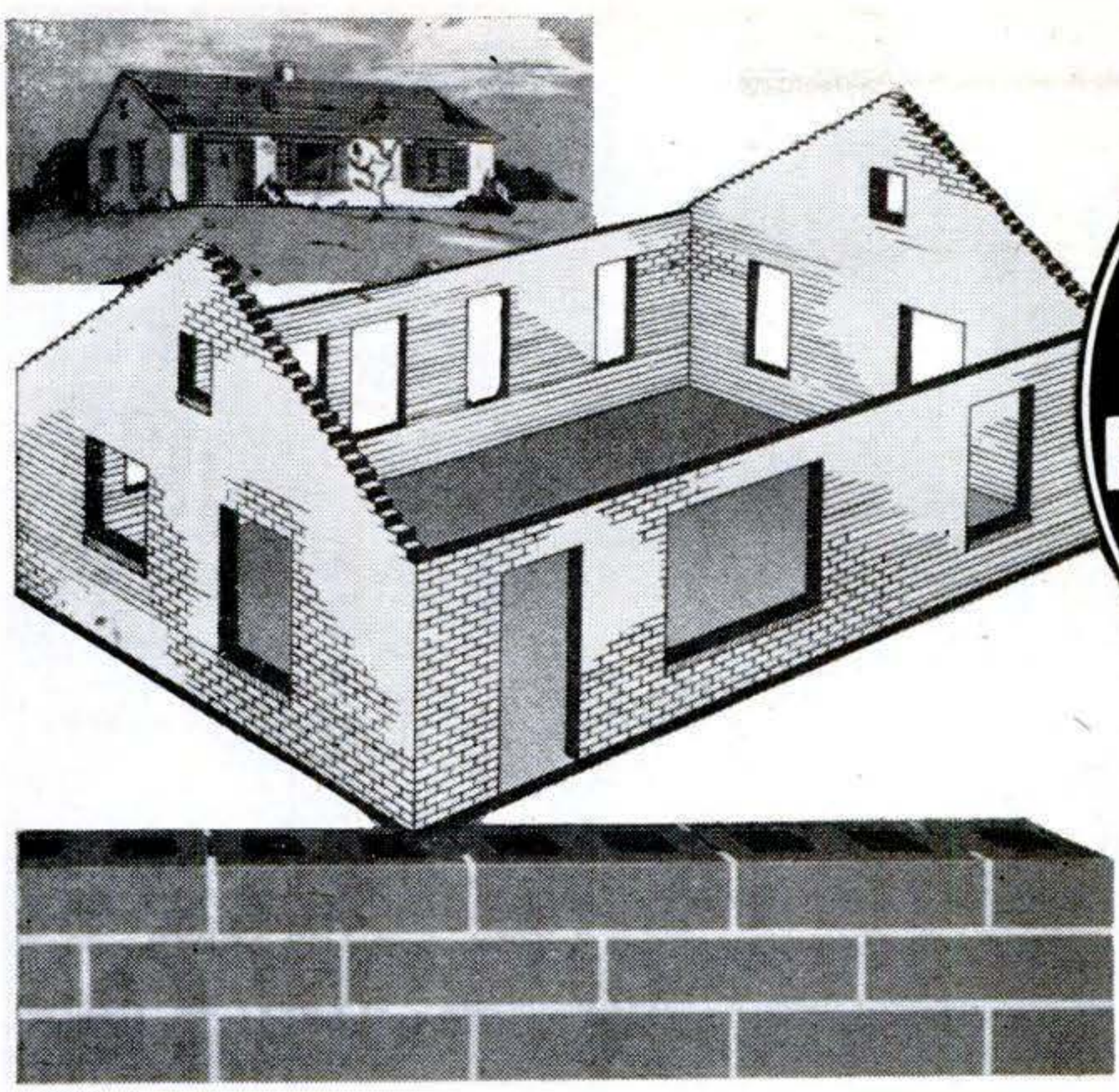

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Based on a national average price of 31c per square foot of 8-inch wall, with net of 758⅓ square feet in bungalow shown. Pro-rata costs on other plans.

Think of it! All the units for all the exterior walls of this roomy bungalow—or any other building of equal square foot area—for less than $270.00. And sufficient 4" units for all partition walls for less than $130.00. This is real economy.

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Brikcrete—and Brikcrete ALONE—combines the five considerations which influence the selection of a residence wall: beauty, permanence, low price, safety, and comfort. With the added advantage of permanently low upkeep and depreciation costs.

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Contact your local Brikcrete manufacturer. You'll find him helpful and cooperative. Or write us for literature and name of Brikcrete plant nearest you.

BRIKCRETE ASSOCIATES, INC.
4677 S. Division Ave. Grand Rapids, Mich.

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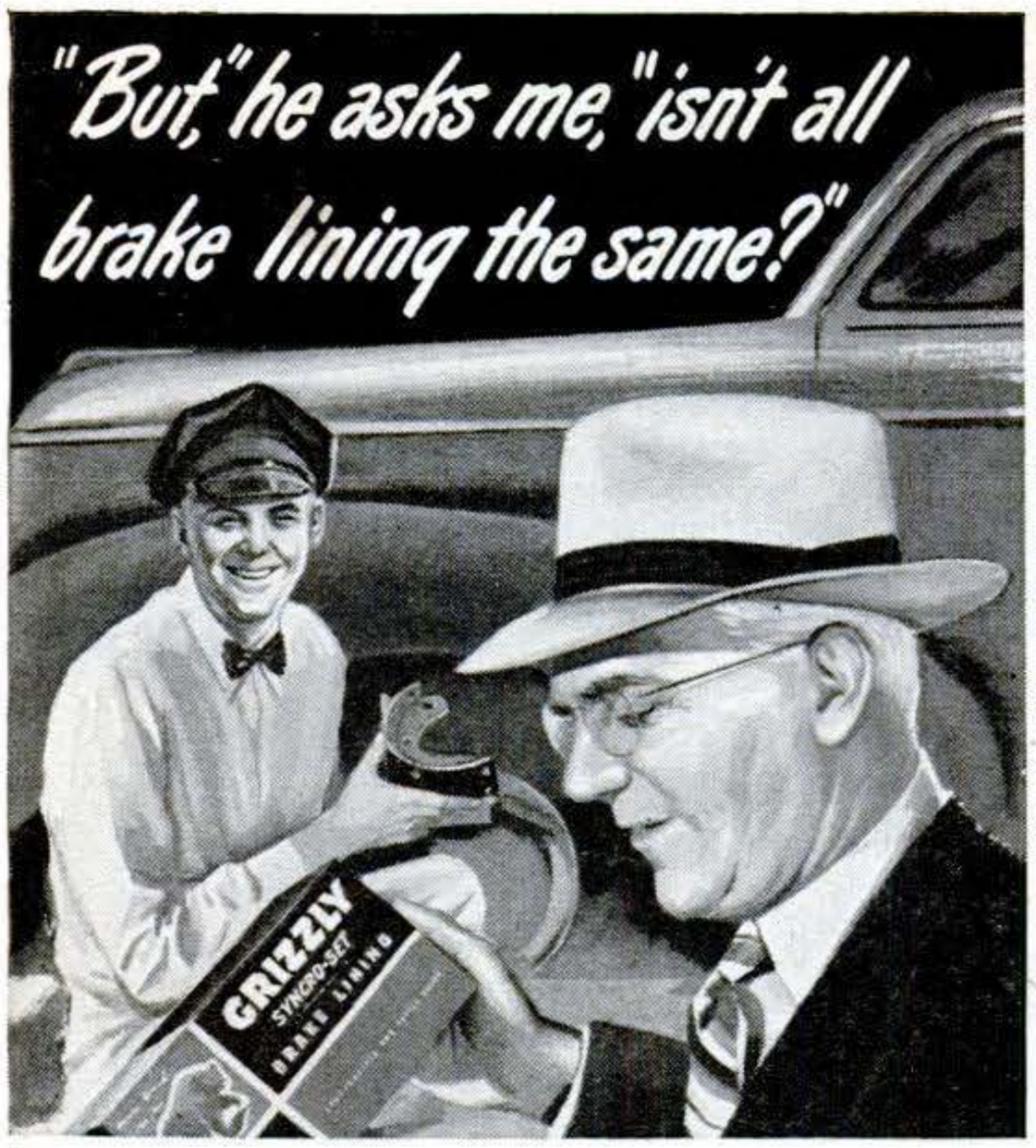

"Look, Joe," he says, as he watches me reline his brakes. "Isn't all brake lining the same?"

"Not quite," I answer. "For example, Grizzly Brake Lining is an exclusive, asbestos-friction compound, molded on a strong wire grid back. There are plenty of other features too, but what's most important is the way Grizzly gives better braking action to both 'Big Foot' and 'Little Foot' drivers."

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"Just this," I reply. "The many fine Grizzly features assure superior brake performance in the largest trucks down to the smallest passenger cars. Women, as well as men, find Grizzly gives them quick, smooth, sure stops with a 'soft' pedal."

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"Don't worry," I assure him. "Grizzly and I make a combination that satisfies every time!"

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WHEREVER BRAKES ARE SERVICED

Amazing **NEW!**

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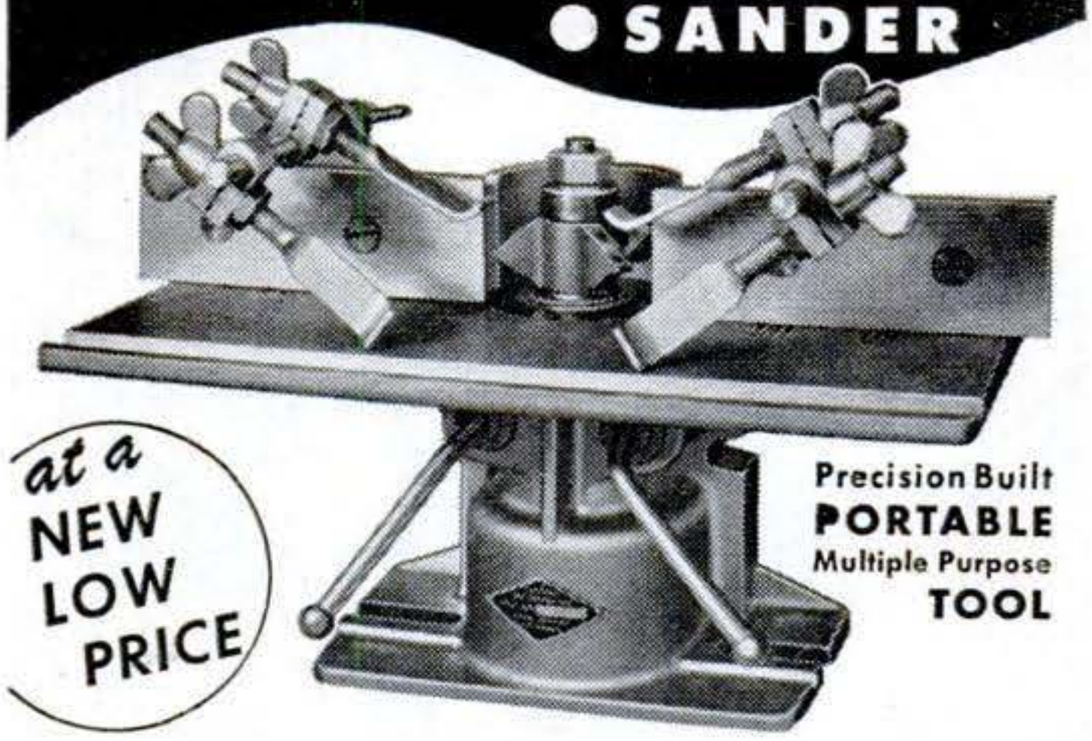

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Here is **convenient, low cost** communication for you! Use it from house to garage, to workshop, barn, etc. **Easy** to install. Just hook up terminals to any two strand wire; several phones on same line if desired. Uses standard flashlight type batteries; **long lasting.** Good for miles. Complete with canvas or leather case.

NEW complete per pair (canvas case) **$29.50**
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SWITCHBOARDS, handle up to 12 telephones, used.....**$45.00**
New Telephone wire, 500 ft., **$3.50,** ½-mile reel, **$10.50.** 1-mile reel, **$16.00.** Subject to prior sales. FOB Sacramento.

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READY FOR IMMEDIATE DELIVERY!

Model No. 2000

SYNCRO

DELUXE JIG SAW

For HOBBYISTS, CRAFTSMEN and LIGHT PRODUCTION

ONLY $17.50 FOB FACTORY

Shpg. Wt. 18 lbs.
Prices slightly higher in foreign countries

Complete with cord, 3 blades.

NO MOTOR NEEDED—JUST PLUG IN! PORTABLE . . . SAFE . . . CUTS CLEAN AND SMOOTH—NO SANDING NECESSARY!

ANNOUNCING a remarkable, PATENTED, MAGNETIC Jig Saw—better-performing, better-quality than famous PRE-WAR **SYNCROS**—now ready for immediate shipment anywhere! **SYNCRO** needs no belts, **no** gears, **no** oiling. **No** motor to buy. This high-speed, short stroke action, and freedom from belts, makes **SYNCRO** so safe even small boys and girls may operate it. Get this husky, powerful, 18 pound saw . . . so easily portable . . . you can use it anywhere—even on the kitchen table . . . so smooth-cutting no sanding is necessary! Cuts **intricate** designs on ⅝" soft wood, ½" medium hard plywood and thinner hardwoods, plastics, thin metals. Leaves **no** ragged undersides on plywood or heavy cardboard. The rapid action blade cuts to the center of a 27" circle. **SYNCRO** is a rugged, powerful power tool for exceptionally high quality work. Ideal for hobbyists, craftsmen, light production. Perfect for models, displays, puzzles, inlays, silhouette, toys, marquetry, games, what nots, etc. Order yours now on our 10 Days Money Back Trial offer—enjoy a **lifetime** of use!

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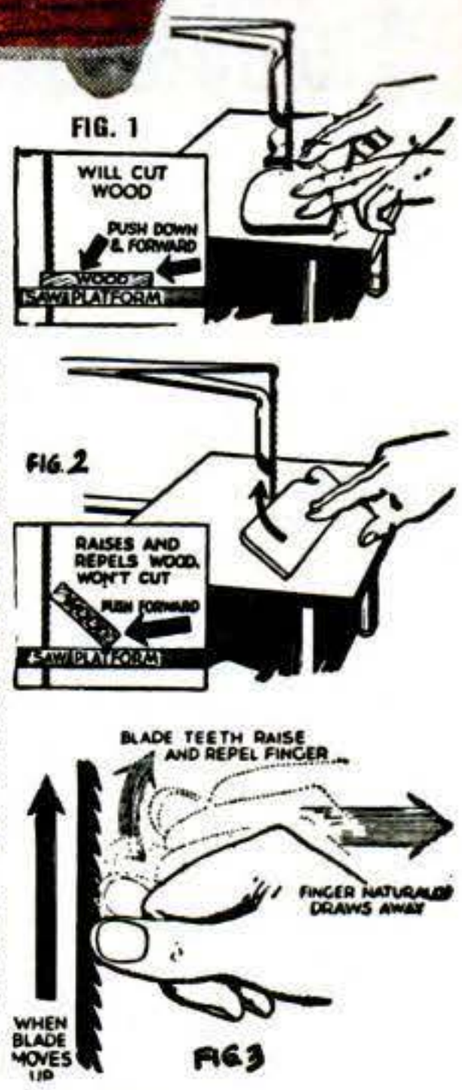
(1) WORLD'S SAFEST SAW. (2) PORTABLE . . . plugs in to 50 or 60 cycle A.C. 110-130 volt wall outlet. (3) NO ROTATING MOTOR NEEDED, SYNCRO'S self-contained magnetic power unit transmits A.C. magnetic impulses to armature diaphragm—power transferred to saw blade. COIL contains 1⅓ lbs. No. 19 insulated copper wire impregnated, baked. **Guaranteed** not to burn out! DIAPHRAGM of spring steel, heat-treated under special process, suspended on L-I-V-E rubber mounting cartridges. (4) 14,400 STROKES PER MINUTE! (5) NO RECIPROCATING OR ROTATING PARTS TO WEAR OUT! (6) NEVER NEEDS OILING. (7) TABLE TOP 10" x 10", a heavy, thick, durable alloy die casting ⅛" thick, ribbed base. **Surface smooth** for easy sliding. Specially finished in half-inch cross sectional engraved lines to assist in accurate cutting. (8) BASE 7½" x 6¾" . . . a heavy, durable die casting. (9) ARM is of specially formed steel stamping ⅛" x 1". **Return Spring** of heavy duty steel. **Guide Slide** of plated steel and **adjustable** to varying wood thicknesses. **Adjustment Screw** permits easy, quick changes to compensate for voltages of 110 to 130 A.C. (10) THROAT CLEARANCE is 13½" permitting work on square sheet of wood, metal, plastic, 27" on the diagonal. (11) 5' cord . . . extension Underwriter's **approved** electric cable with molded rubber plug. (12) BLADES are 5" pin end style of finest steel, 18 teeth per inch. (13) NO-MAR, NON-SLIP RUBBER FEET. (14) DURABLE—will last a lifetime. (15) HIGHEST QUALITY—guaranteed by the trademark name "SYNCRO".

"Family Saw!"

"The **Syncro Power Saw** ordered from you in 1940 is still sawing merrily away. My son, (then 8) has used it in the attic, kitchen, his room, in the basement shop. I use it too. We never worry about accidents due to its **Magnetic Safety Stroke** feature. It's truly **a family saw.**"
Mr. B. H. Smith, Rexburg, Idaho

SAFEST!

SYNCRO has no continuous cutting blade nor "Long stroke" blade to *pull* fingers into *teeth—stead* there are 14,400 strokes per minute—7,200 shortcutting strokes plus 7,200 upward *Non-Cutting, Repelling* strokes! (Fig. 1) SYNCRO will not even *Cut* wood unless piece is pushed *Firmly Downward Against* blade and *Firmly Forward*—both actions at *Same* time! (Fig. 2) SYNCRO blade teeth cut *Only* on *Down* stroke. Teeth raise, repel, push away any object on *Up* stroke. When blade moves *Up* it *Kicks* finger away free. (Fig. 3) On down stroke, blade does not move *far enough* to accidentally cut finger unless finger is *intentionally, deliberately* fed into blade like wood is fed in Figure 1. No wonder SYNCRO is the world's *Safest* saw . . . a **feature** old and young users acclaim!



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So you may order with **complete** confidence, read this SYNCRO TRIAL OFFER: When you get your saw, plug it into any 60 cycle A.C. 110-130 volt outlet and saw according to instructions. Then, if it does not satisfy you **perfectly** in every way, return it postpaid within 10 days of delivery date, and we will refund your $17.50 promptly without questioning. Order now.

HOW TO ORDER—DO IT NOW!

Mail Coupon with Postal Note, Money Order or check for only $17.50 plus Parcel Post or Express **carrying charges** . . . or . . . send $17.50 only and we will ship saw **collect** for Parcel Post or Express **carrying charges only.** Specify type of delivery **on Coupon.** Shipping weight, packed, 18 lbs. Hurry! Act promptly—order—we'll ship same day order is received. (No **complete** COD orders accepted.)

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WORLD'S SAFEST SAW

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ROCHESTER, MICHIGAN

EXPORT ADDRESS: 120 WALL ST., N. Y. CITY
WORLD'S LARGEST MAKERS OF ELECTRIC JIG SAWS

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☐ Express charges collect or ☐ (Parcel Post) charges collect.
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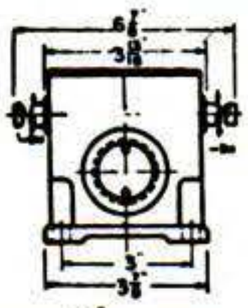

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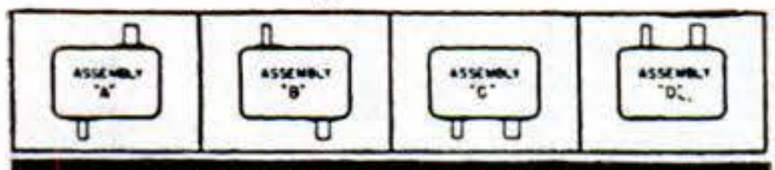

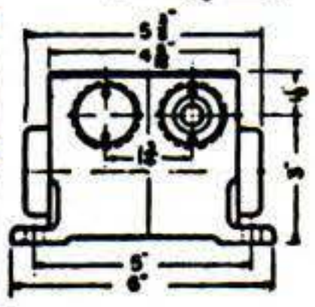

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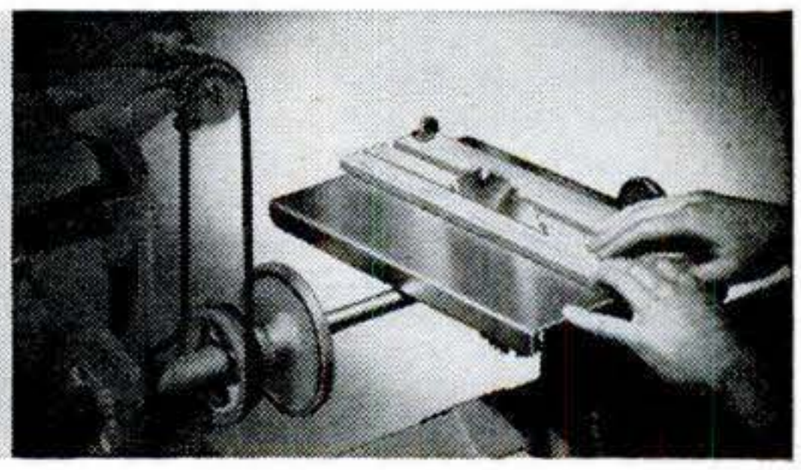
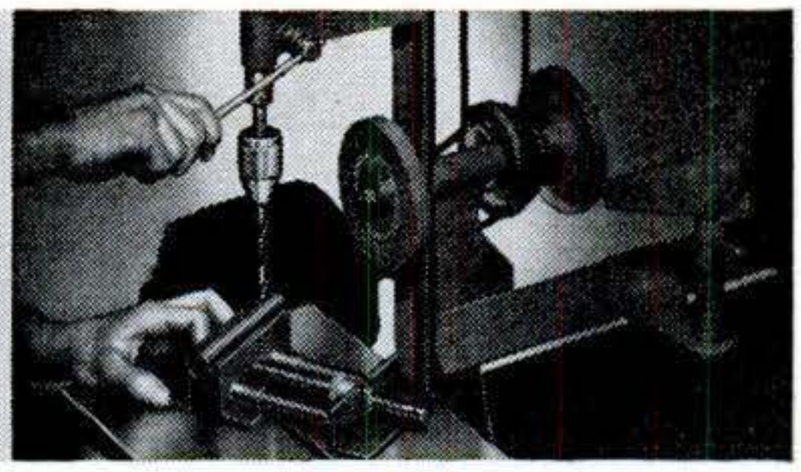


DRILL PRESS
Takes drills to ½". 2" travel, ½" spindle.
Drills to center of 12" circle.



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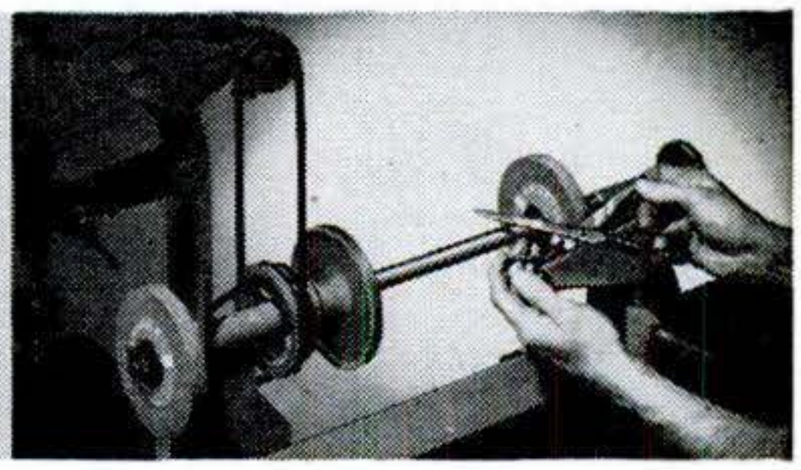
Spindles mounted in replaceable bronze bearings.



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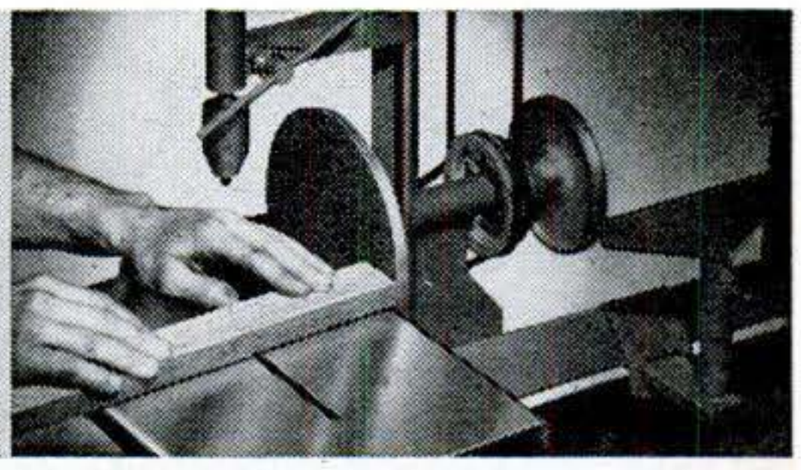

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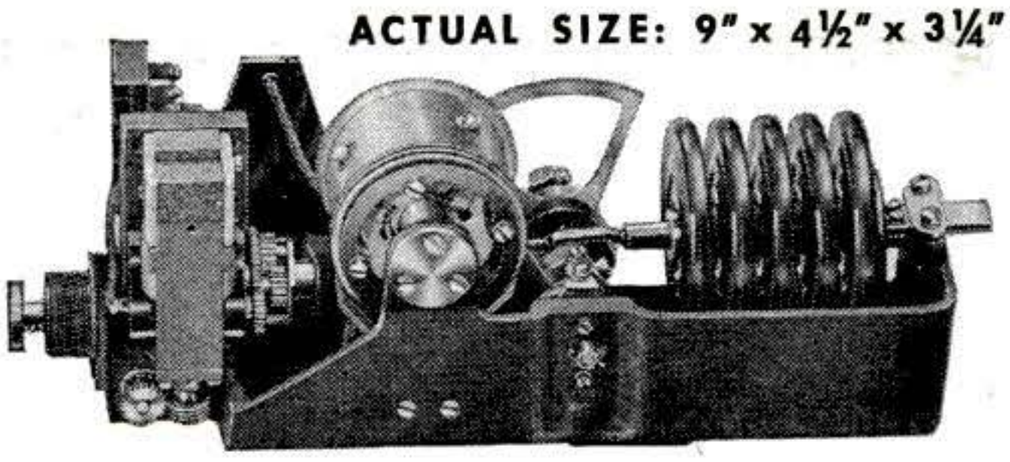
ACTUAL SIZE: 9" x 4½" x 3¼"



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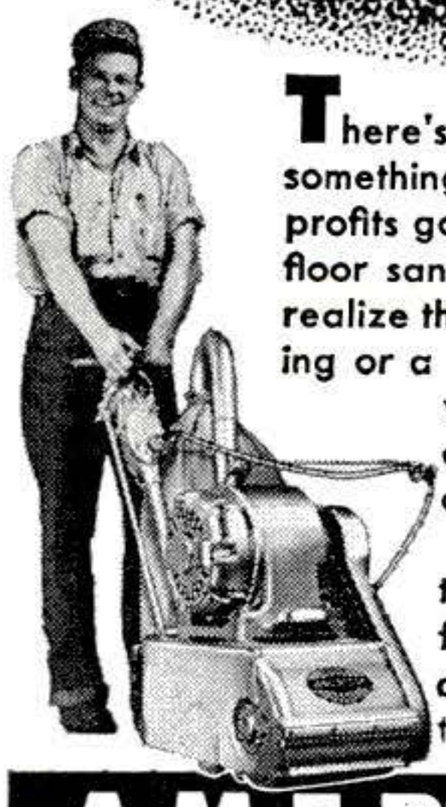

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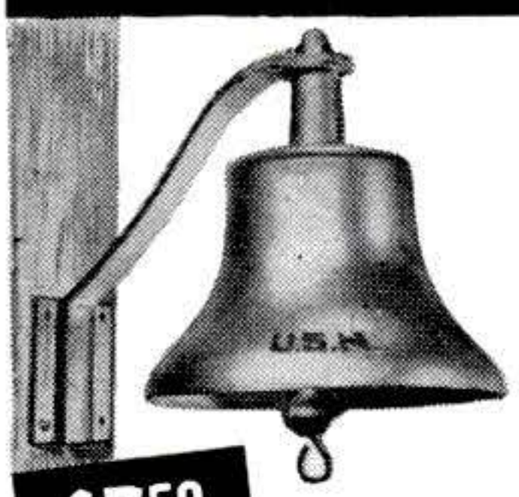

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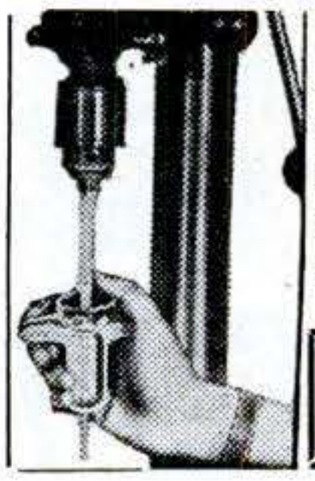

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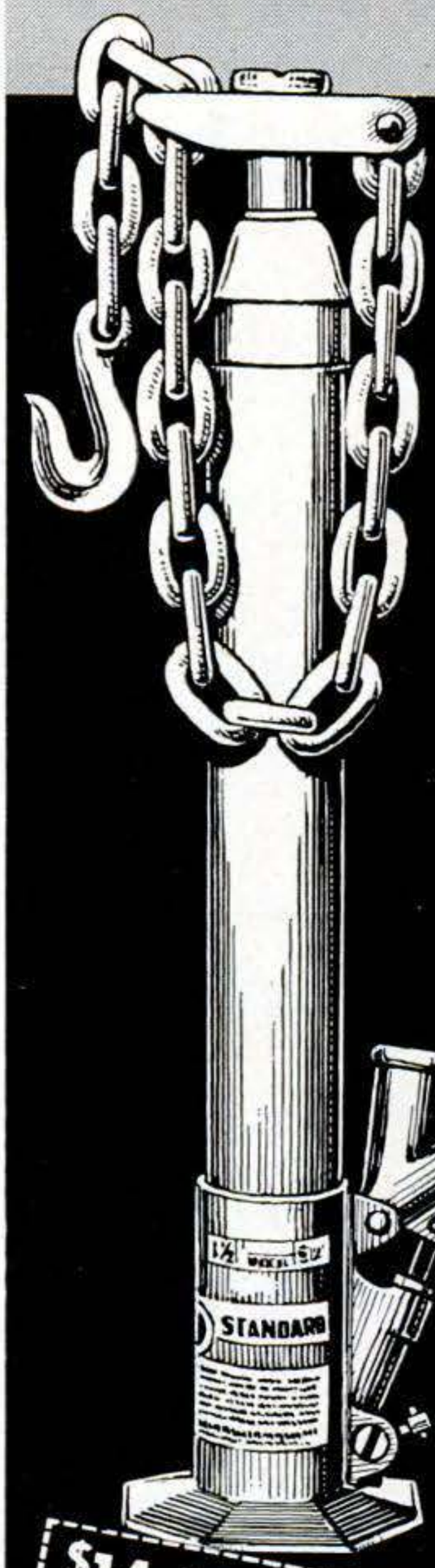

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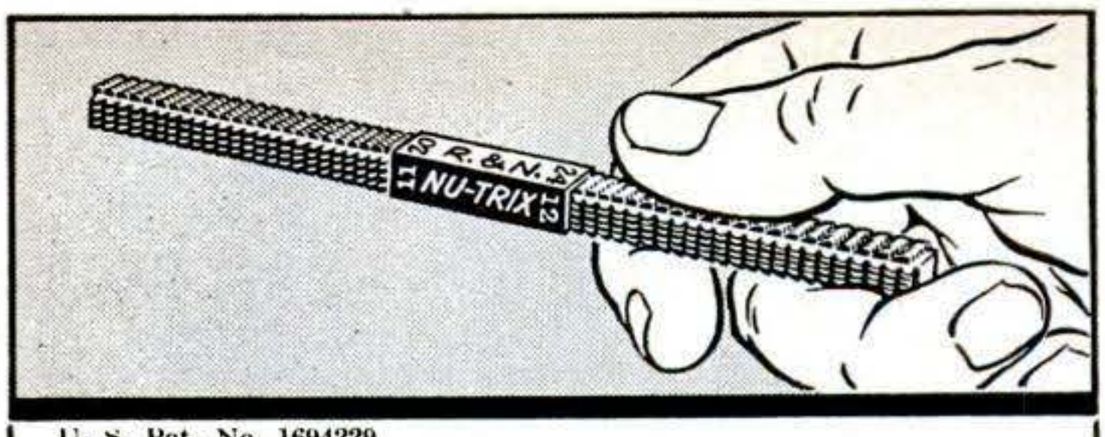

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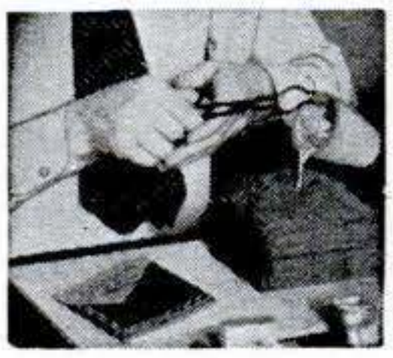

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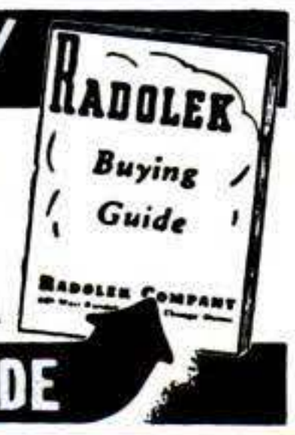

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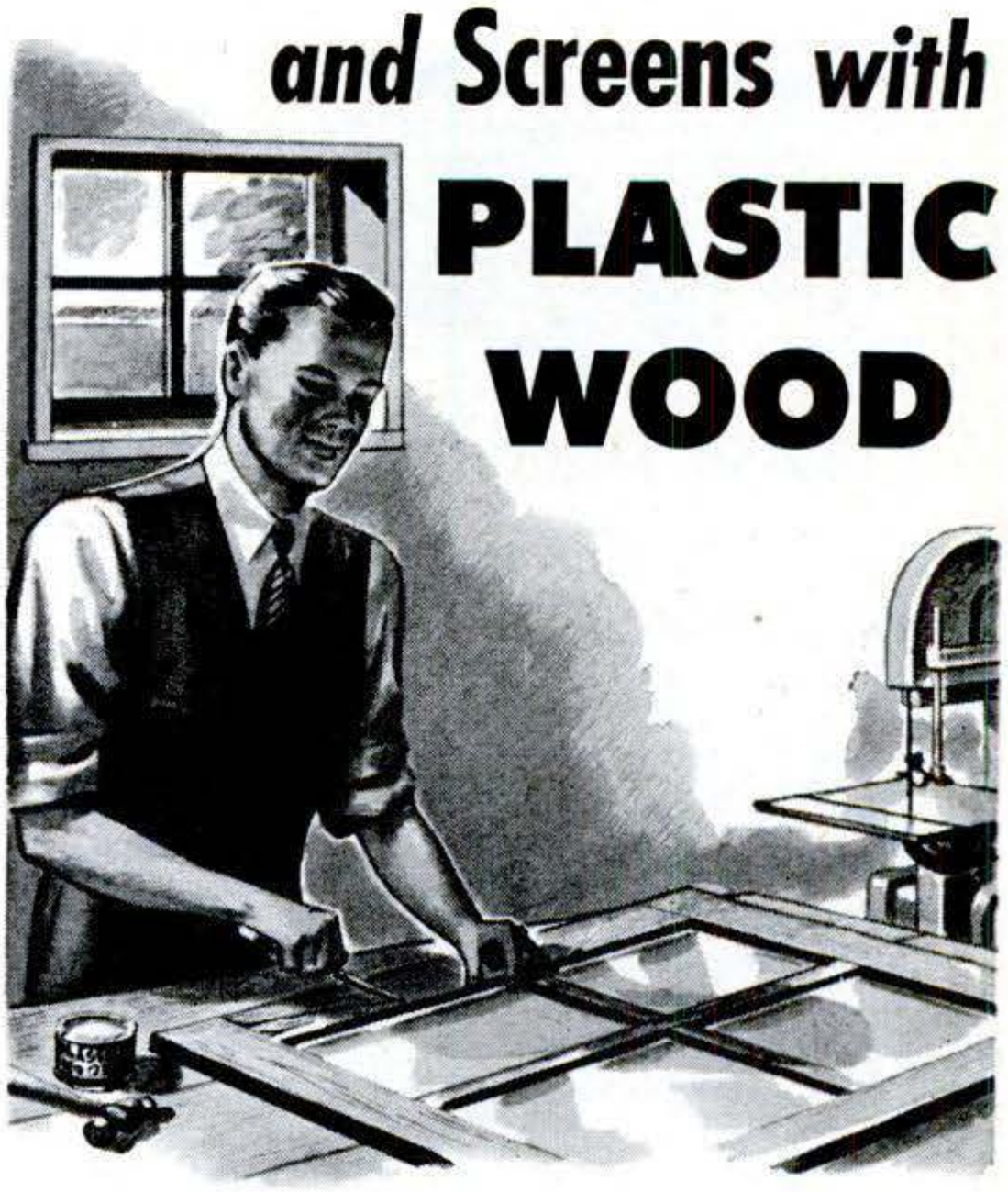

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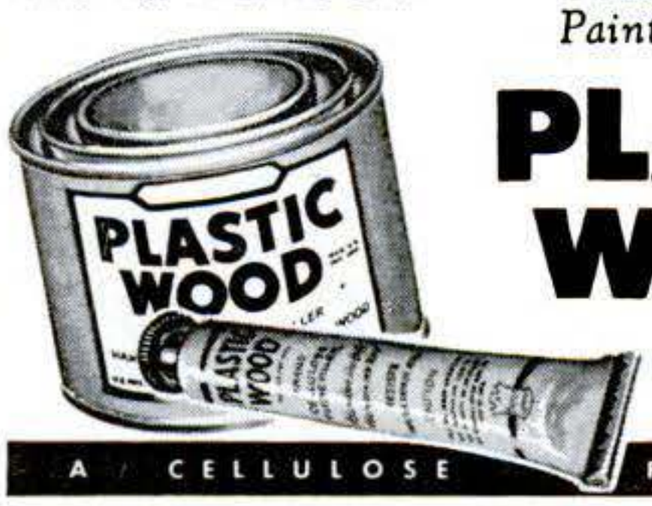

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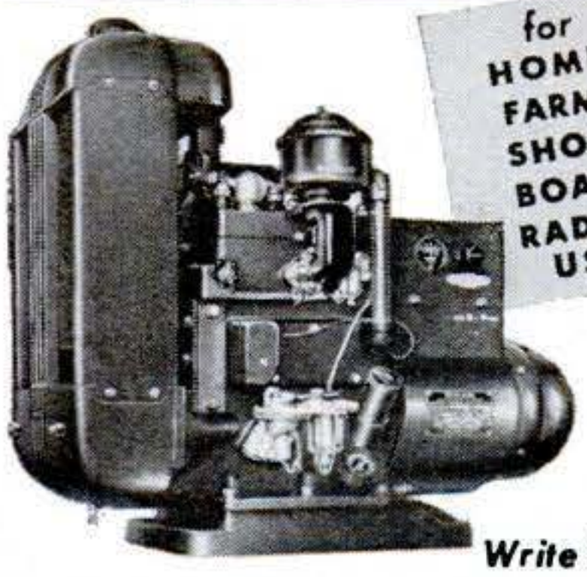

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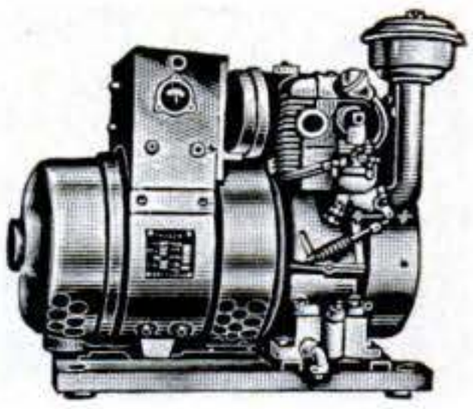

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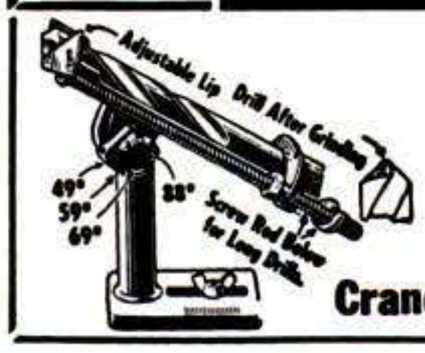

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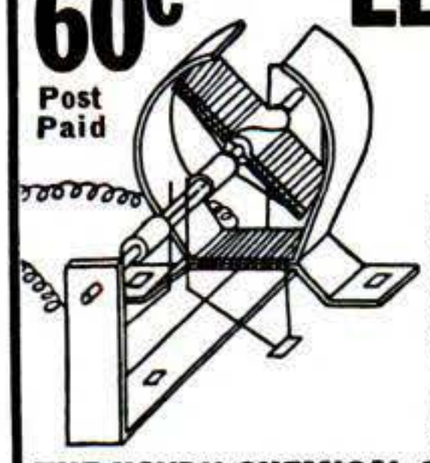

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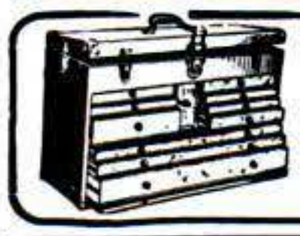

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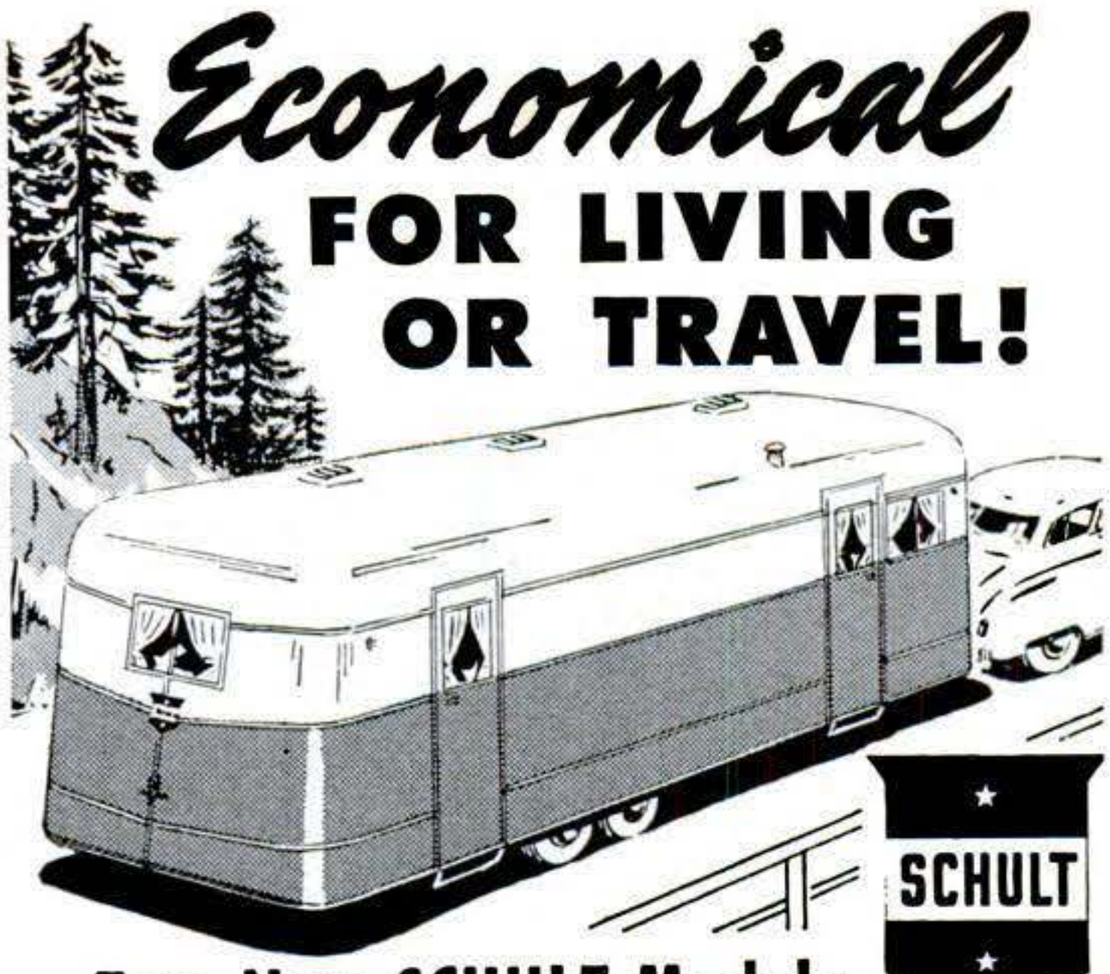

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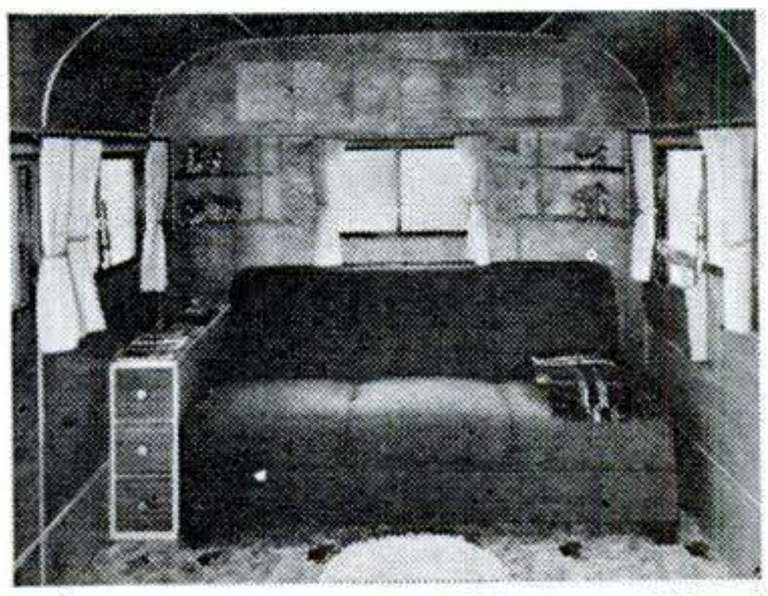

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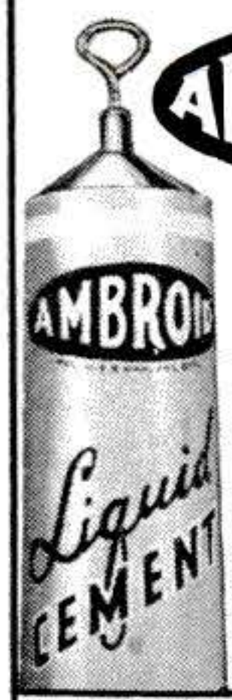

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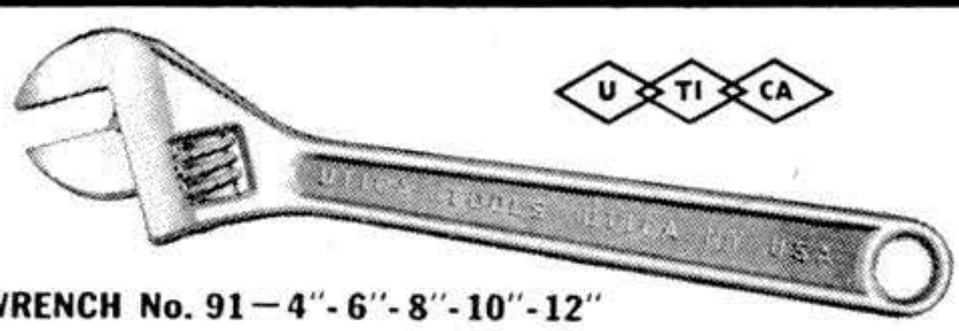

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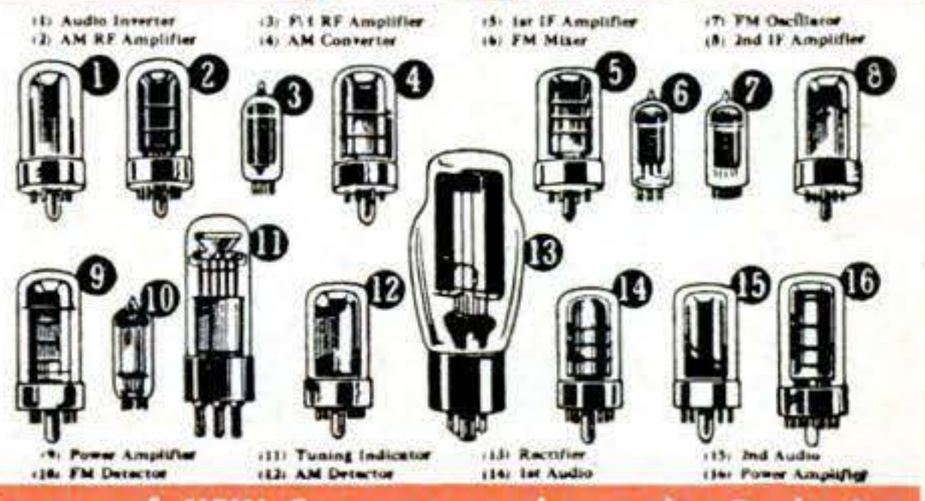

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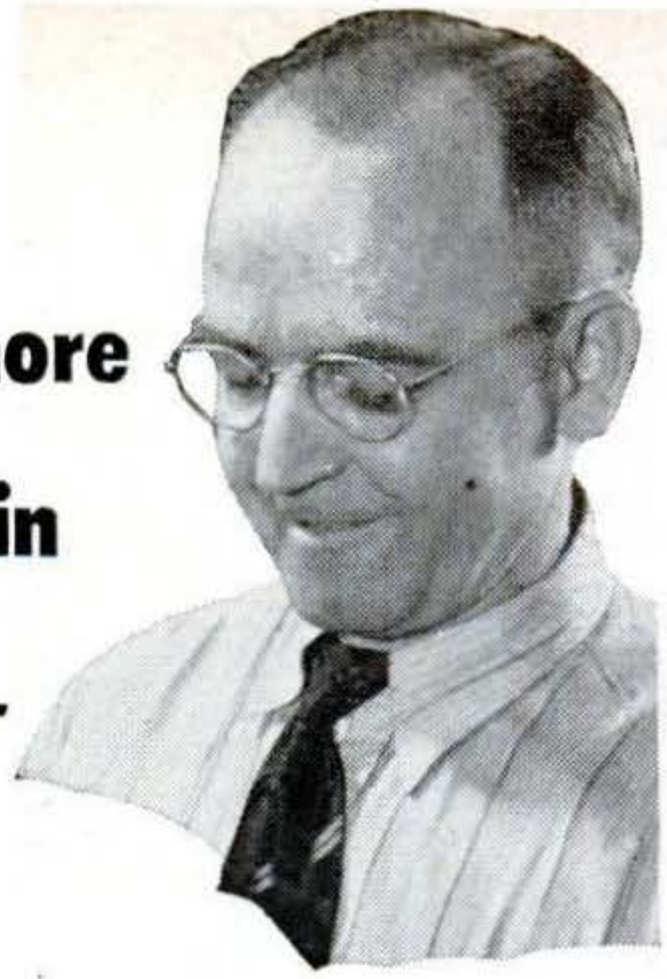

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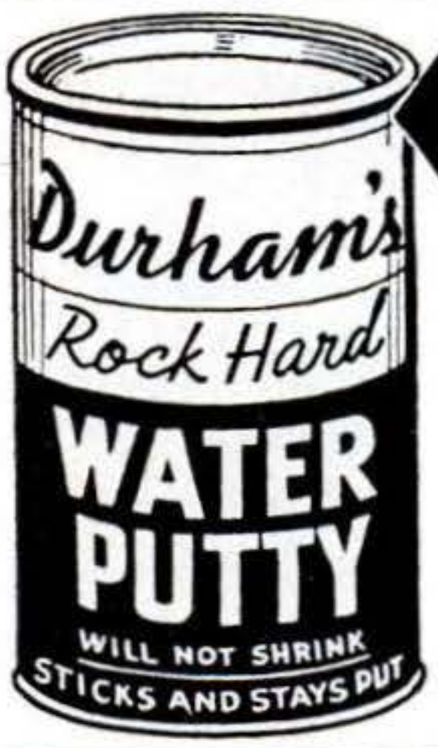

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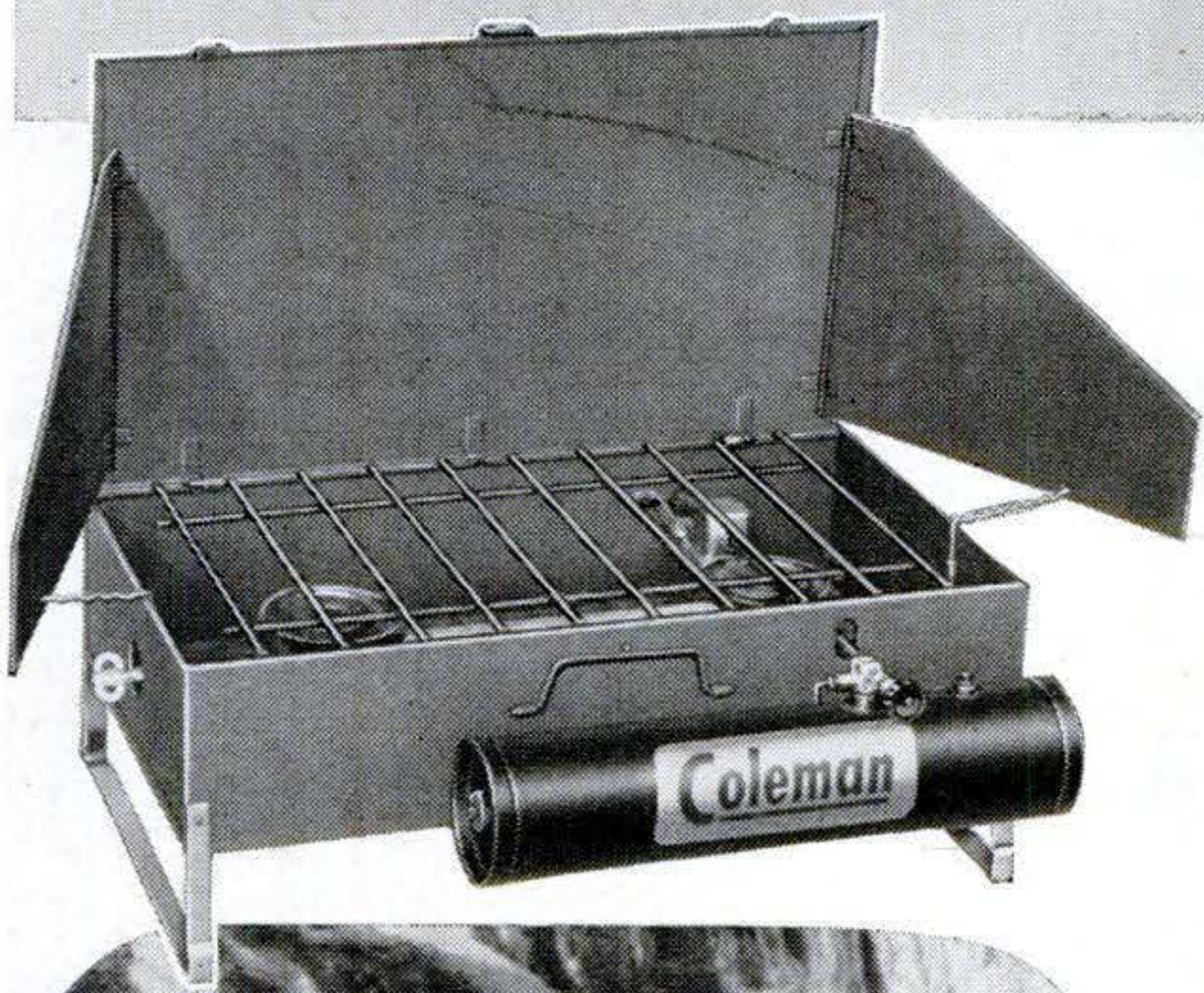

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Easy meals... more fun... less work... better eats... anywhere with a Coleman Camp Stove. It's the speedy answer to outdoor appetites — ready at the touch of a match and the turn of a valve. Cooks like a gas range. Bakes, boils, roasts, fries, broils, toasts.

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The Coleman makes and burns its own gas from gasoline. Instant lighting. Two wind-proof burners; instantly regulated to any desired cooking heat. See the Coleman Camp Stove at your dealer's. Ask him for free demonstration.

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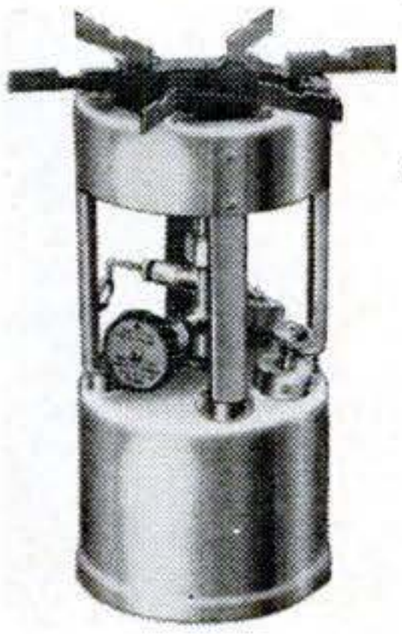

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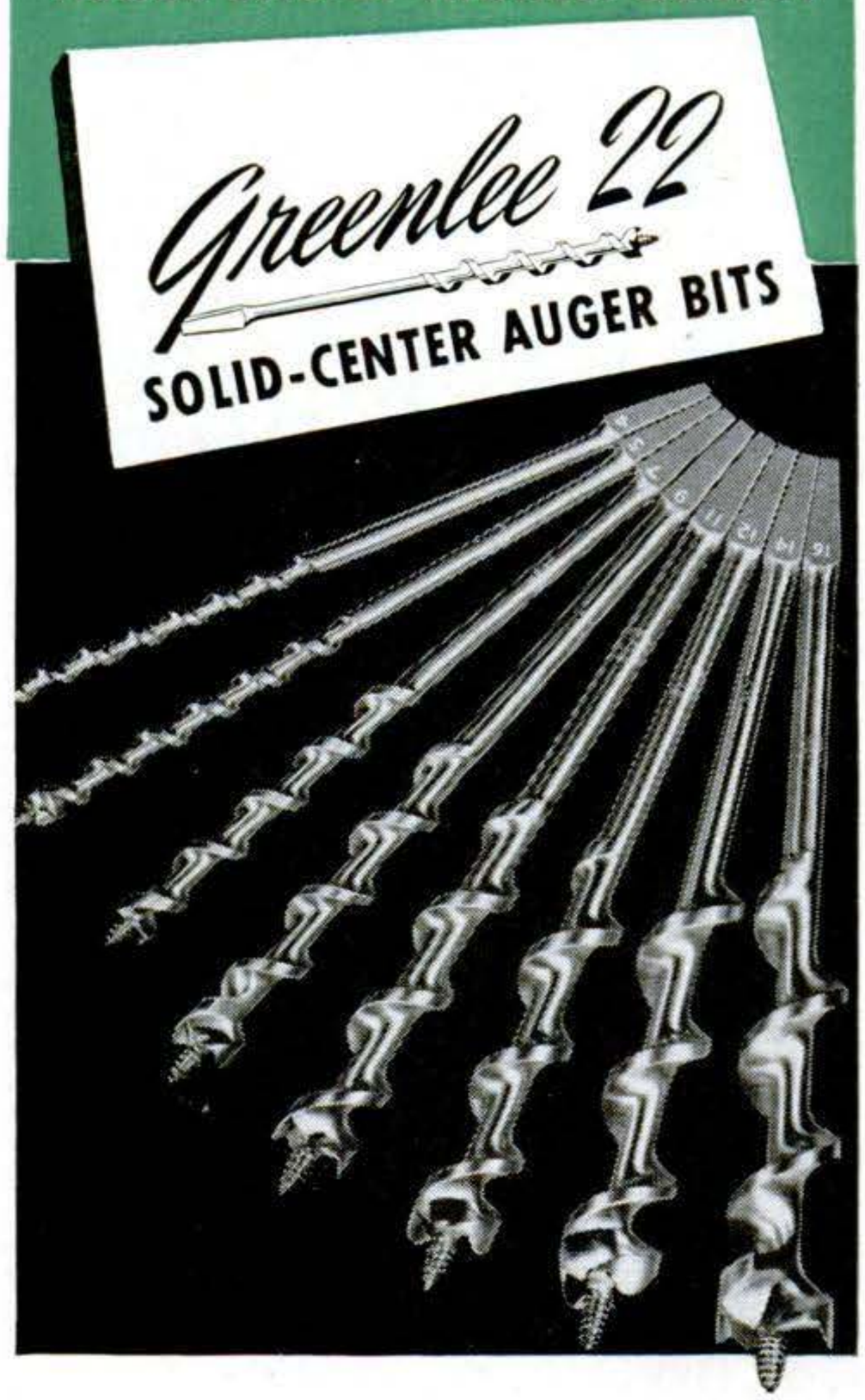

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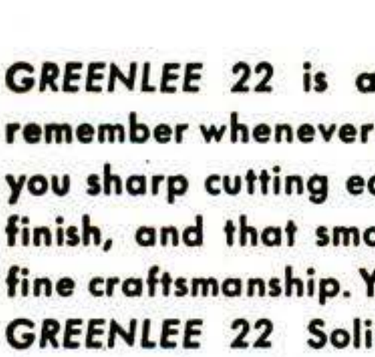

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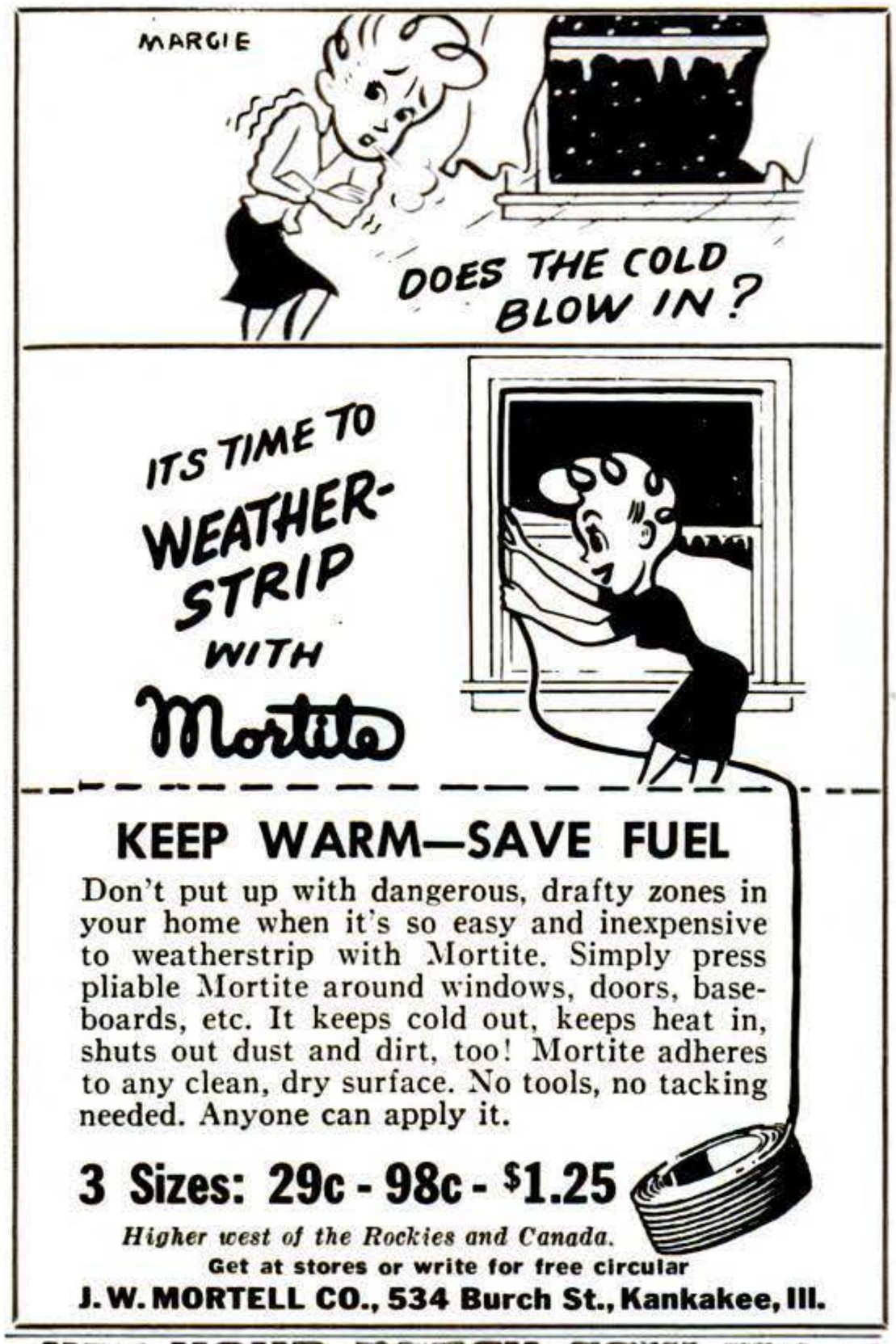

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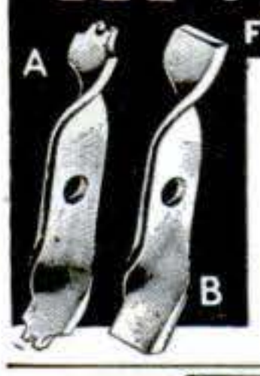

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$65,000 IN AWARDS FOR BOYS

More than 700 awards—8 university scholarships, $1,000 to $4,000 each, cash awards, trips—in the Fisher Body Craftsman's Guild 1948 model-building competition

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Detroit, Mich.
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Douglas C. Brown
Hatboro, Pa.
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$3,000 Scholarship

Donald F. Schonholtz
Hutchinson, Kans.
Duplicate first award;
$5,000 Scholarship

Charles Jordan
Cambridge, Mass.
First award,
$4,000 Scholarship

Wm. Bowman
Bell, Calif.
Second award,
$3,000 Scholarship

Donald A. Stumpf
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Second award,
$2,000 Scholarship

Robert Welther
Detroit, Mich.
First award,
$5,000 Scholarship

James Mariol
Canton, Ohio
First award,
$4,000 Scholarship

John R. Chadima
Cedar Rapids, Iowa
Duplicate first award;
$5,000 Scholarship

Philip Rauth
York, Nebr.
Second award,
$2,000 Scholarship

Major Award Winners 1947 Competitions

Any boy 12 years old or over and not yet 20 on September 1, 1947, may enter the competition to design and build a model car. Junior and Senior Divisions with identical awards let you compete with boys your own age. There are no dues or entrance fees, and awards include Model Builders' Tool Chests, cash, all-expense trips to the Guild convention, and 8 university scholarships worth $1,000 to $4,000 each. (Duplicate awards are given if sons of General Motors employes win.)

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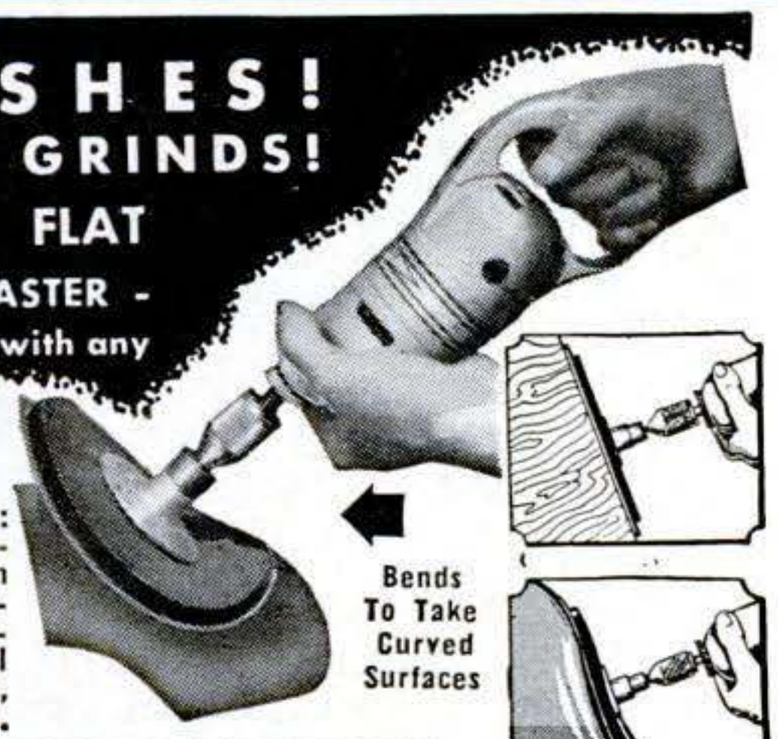

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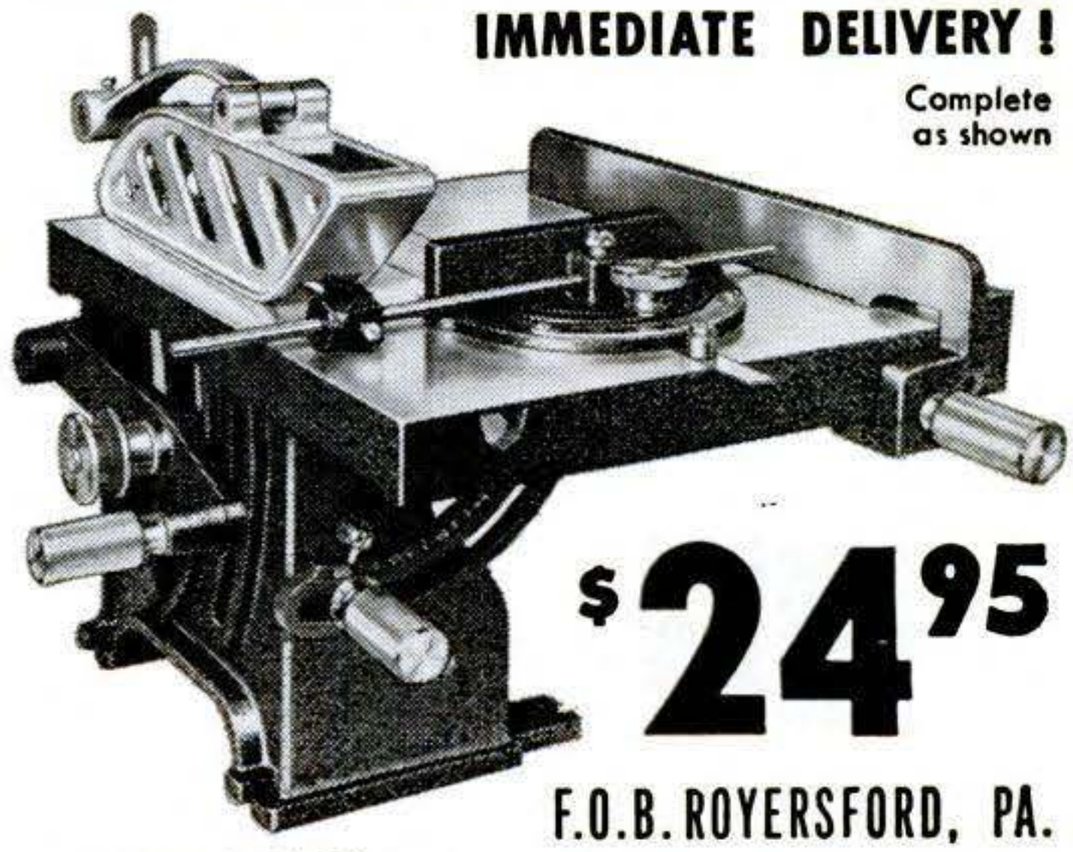

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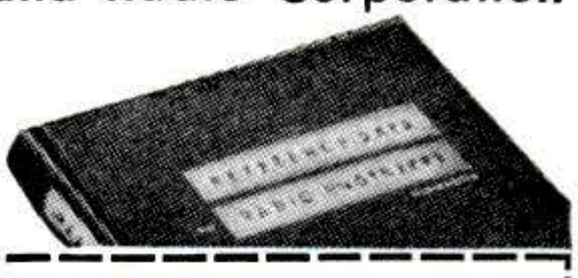

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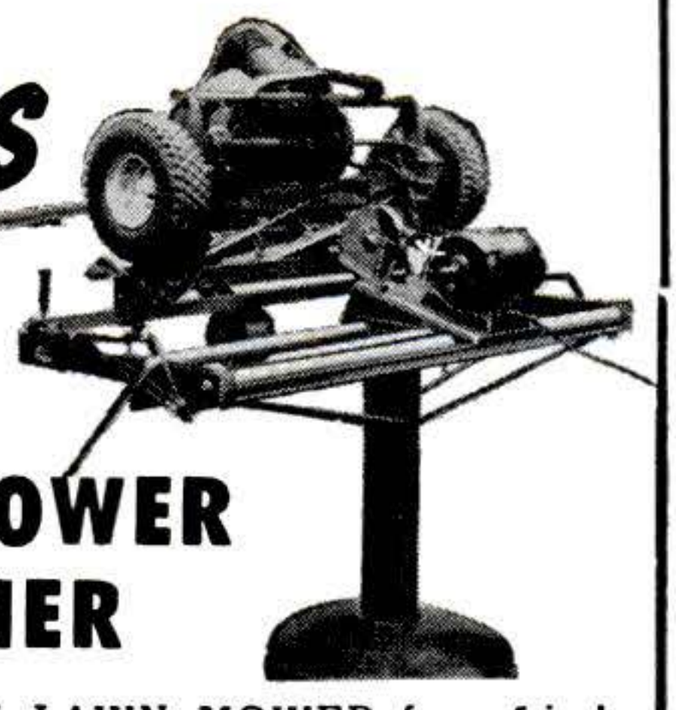

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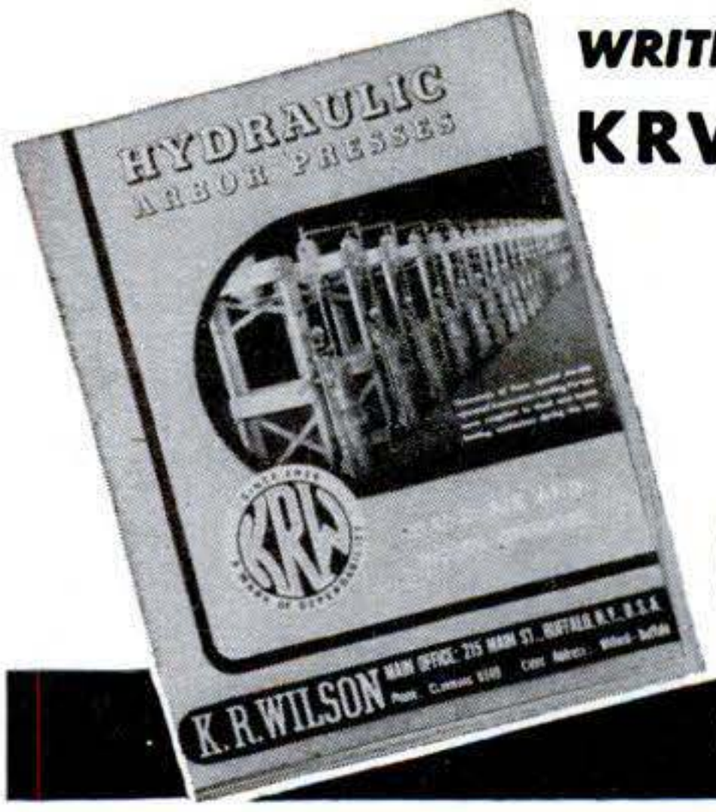

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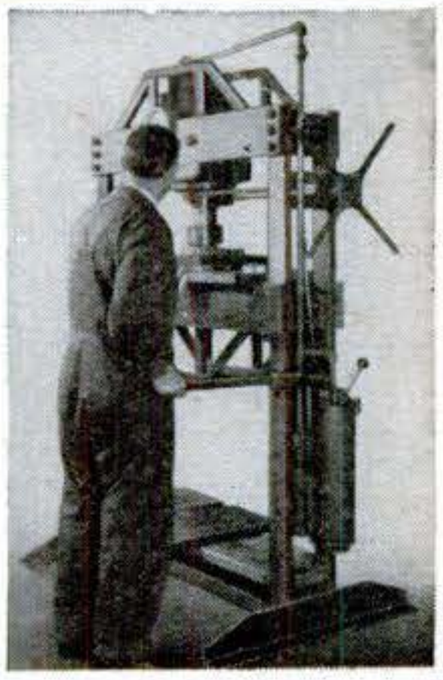

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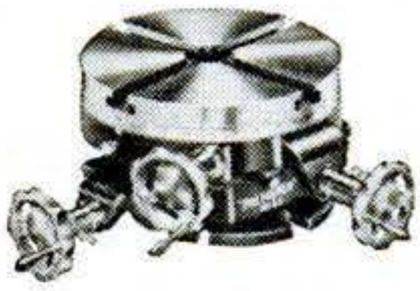

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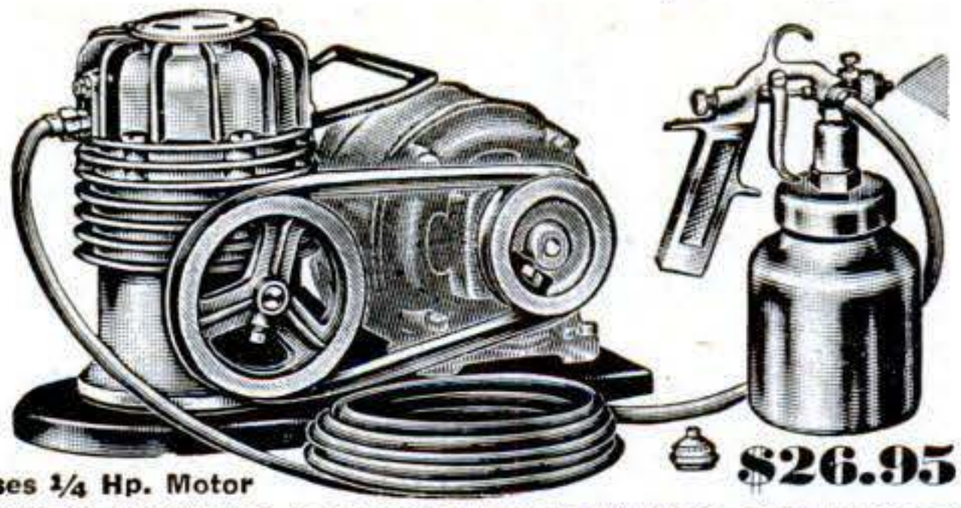

Uses ¼ Hp. Motor

$26.95

Complete as illustrated, less motor. Sprays all kinds of paint, lacquer, varnish, etc....Oil-less ball bearing compressor, 2 cu. ft. air per minute. 15 to 50# pressure. Sprays paint 5 times faster than hand brushing.

No. 890. Outfit complete as shown with "V" Belt, motor pulley, 15 ft. high test air hose and No. 112 gun, but without motor. $26.95

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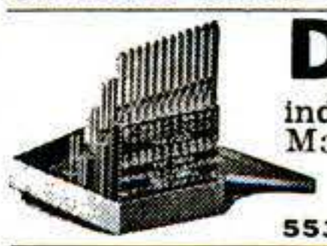

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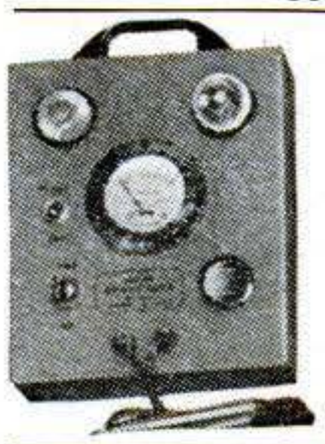

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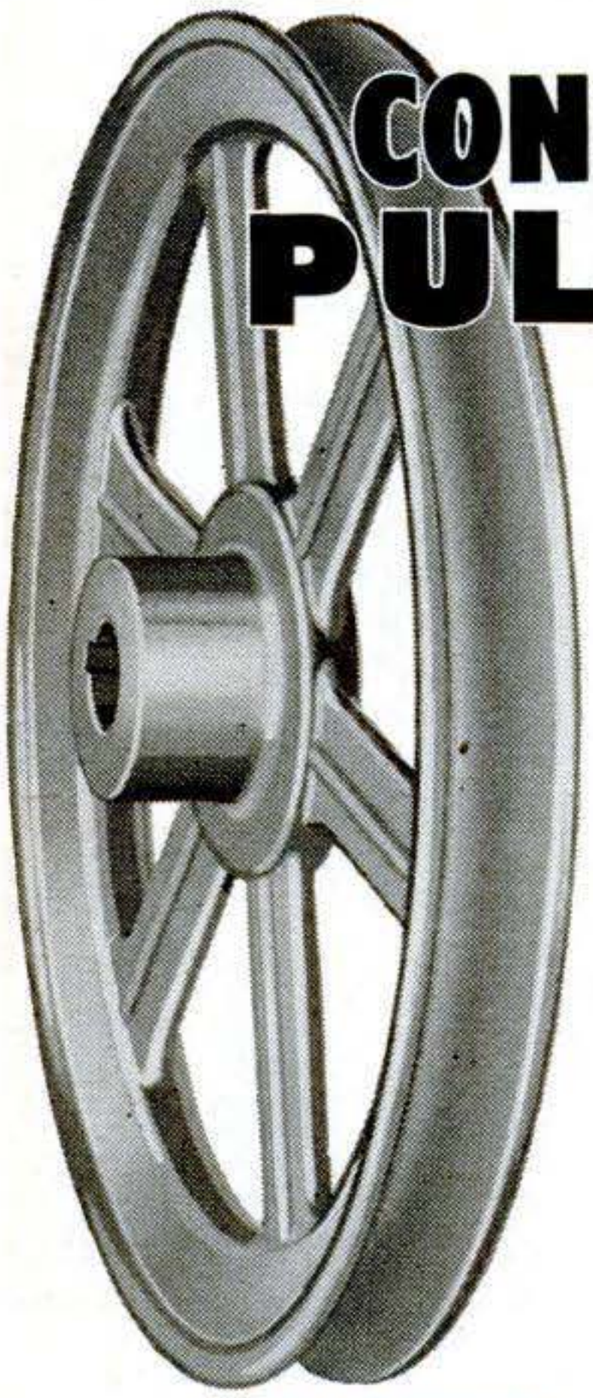

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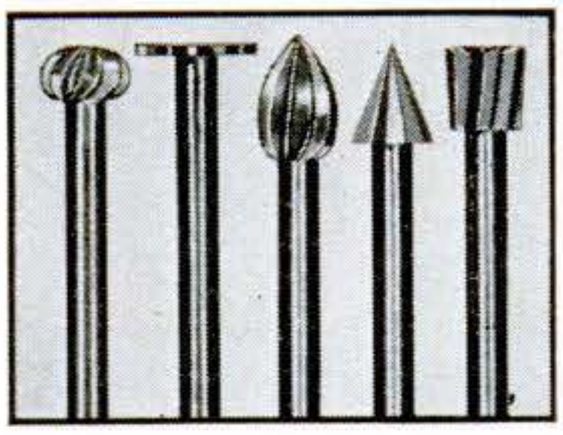

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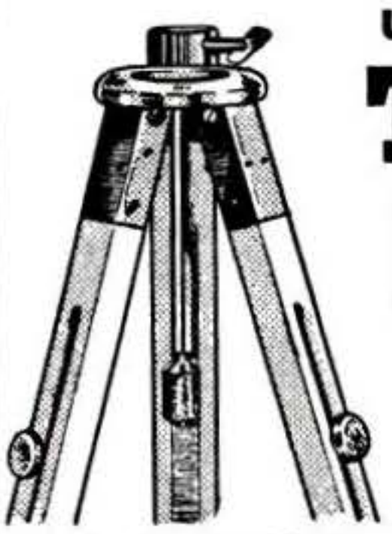

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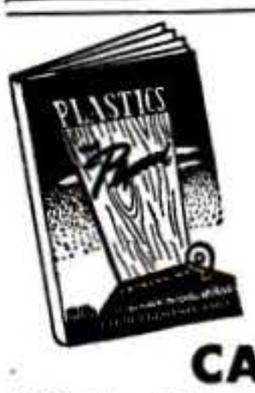

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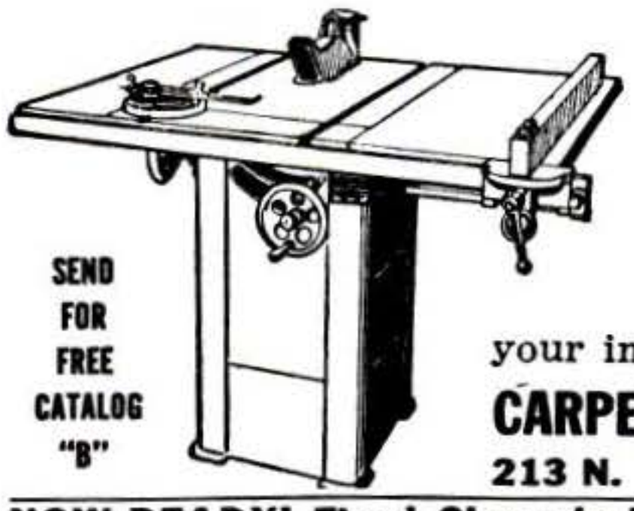

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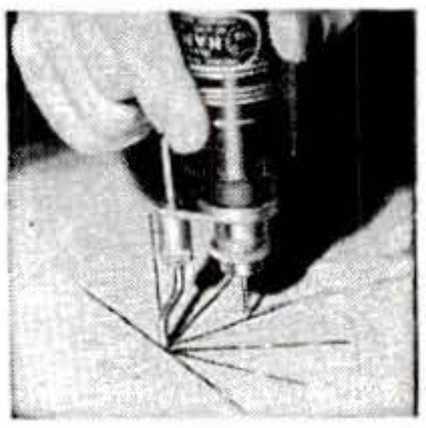

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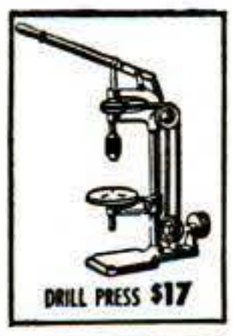
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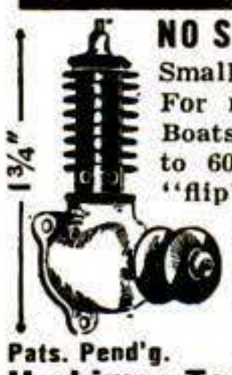

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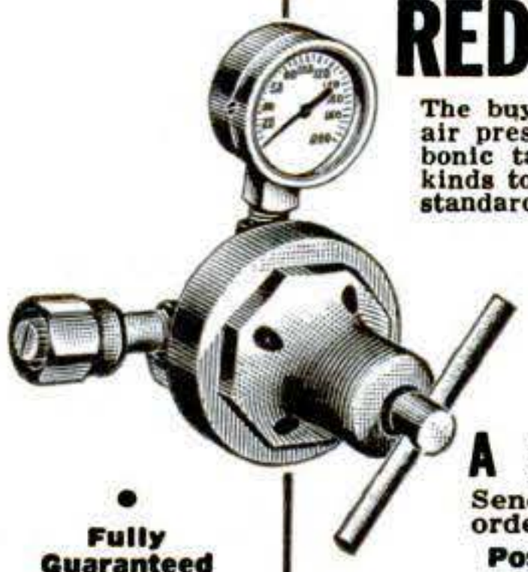

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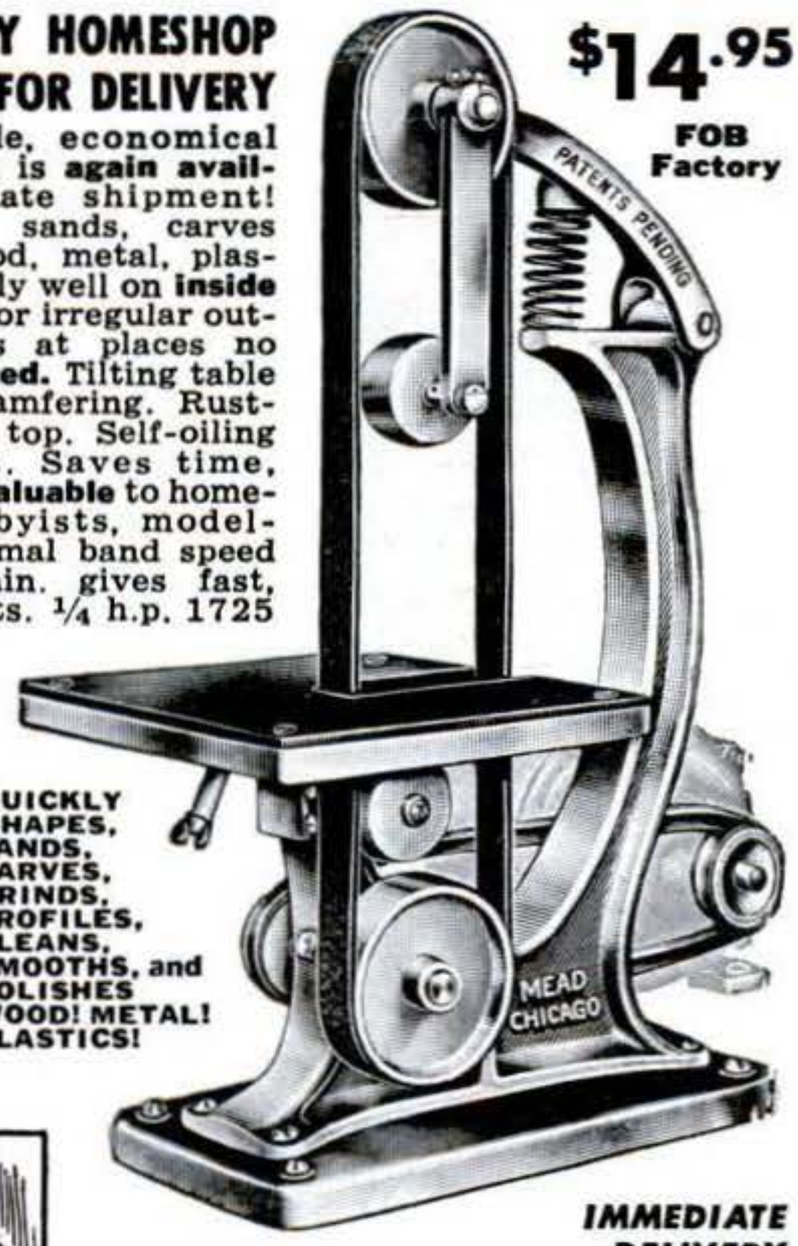

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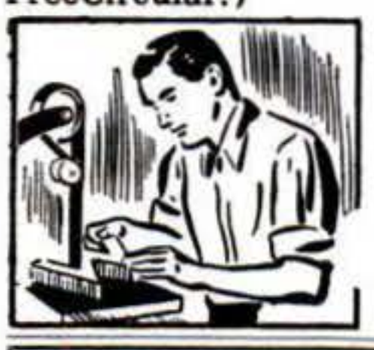

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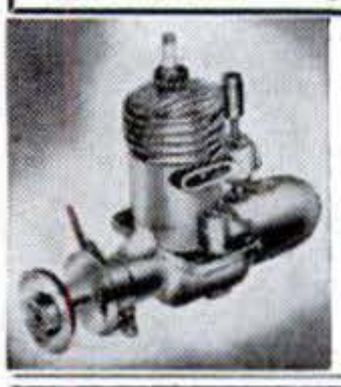

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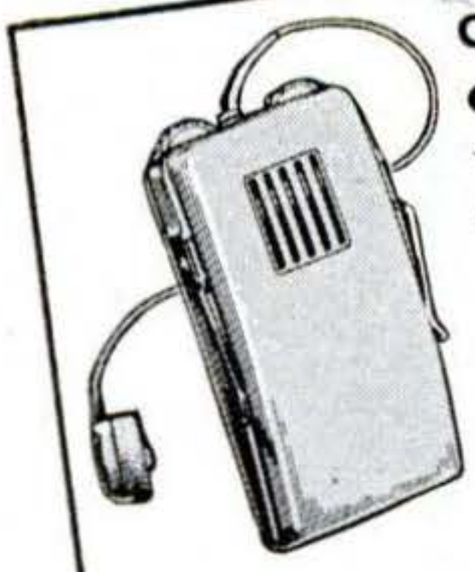

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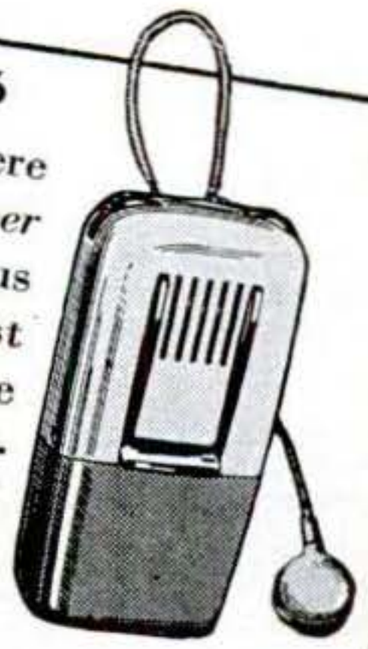

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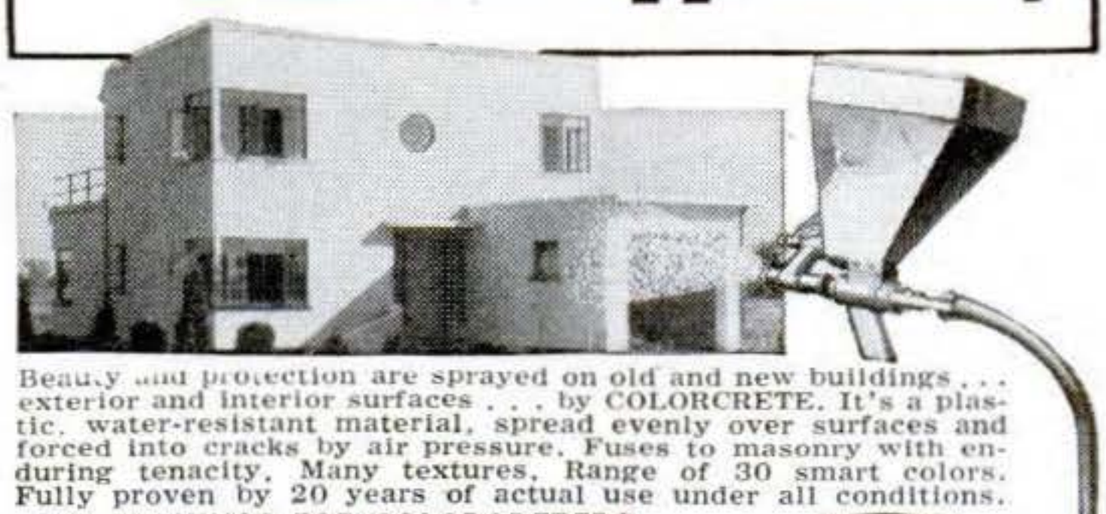

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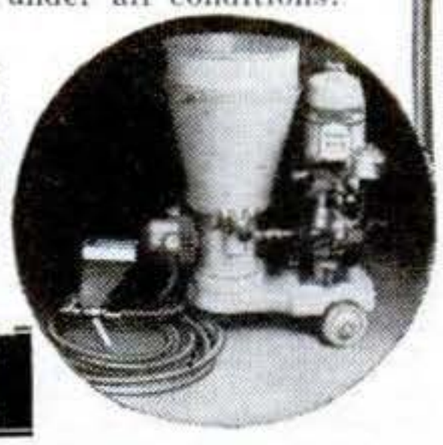

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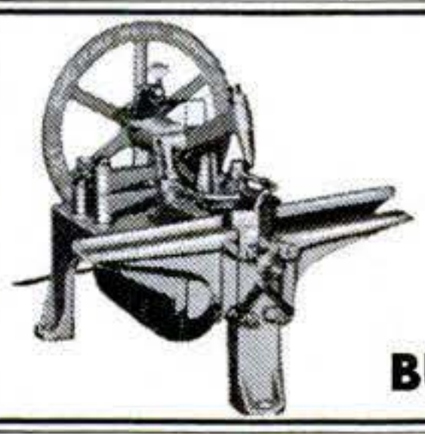

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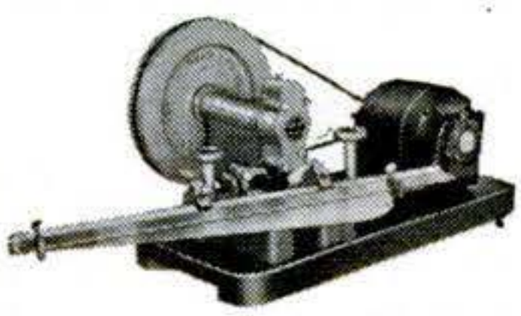

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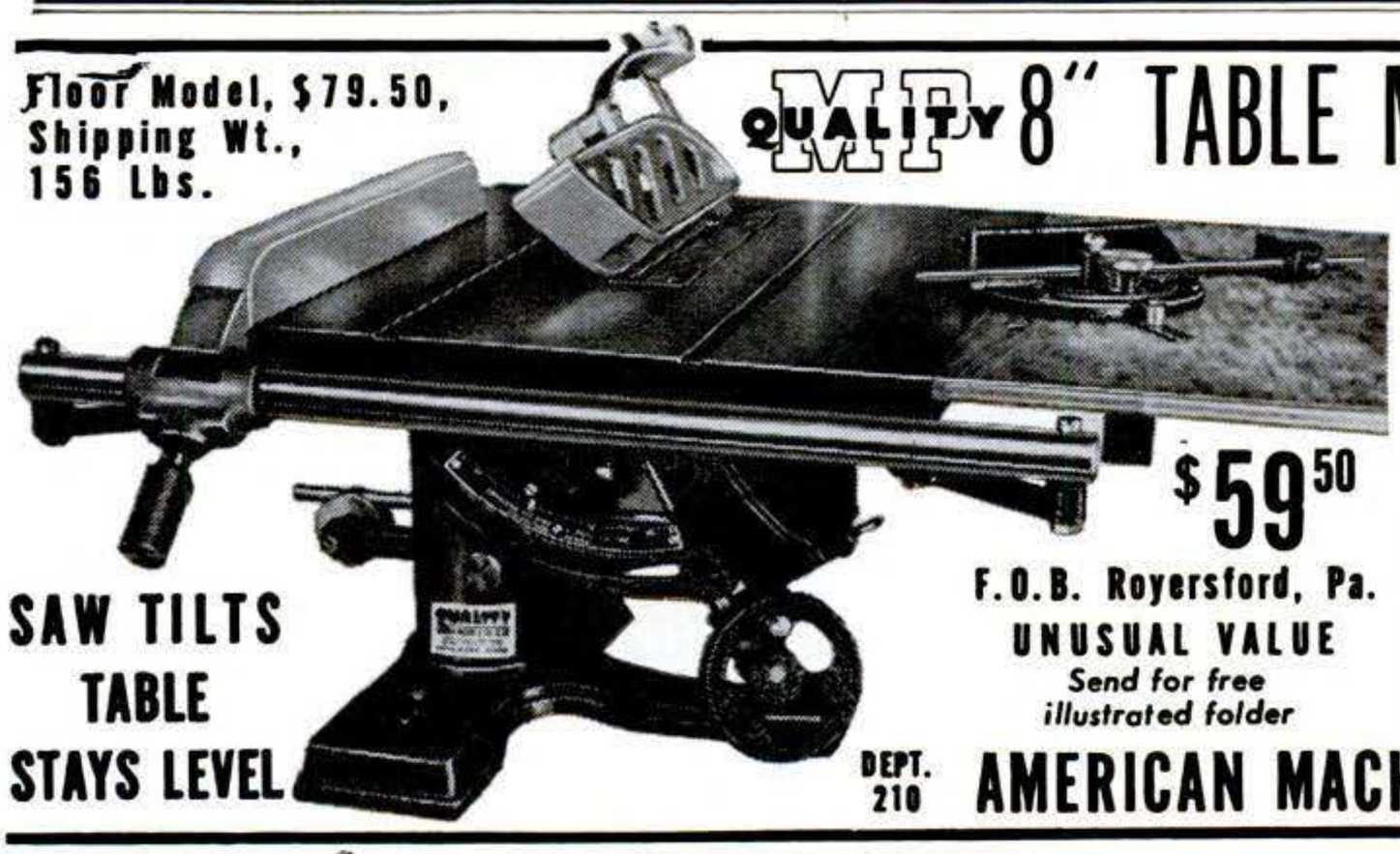

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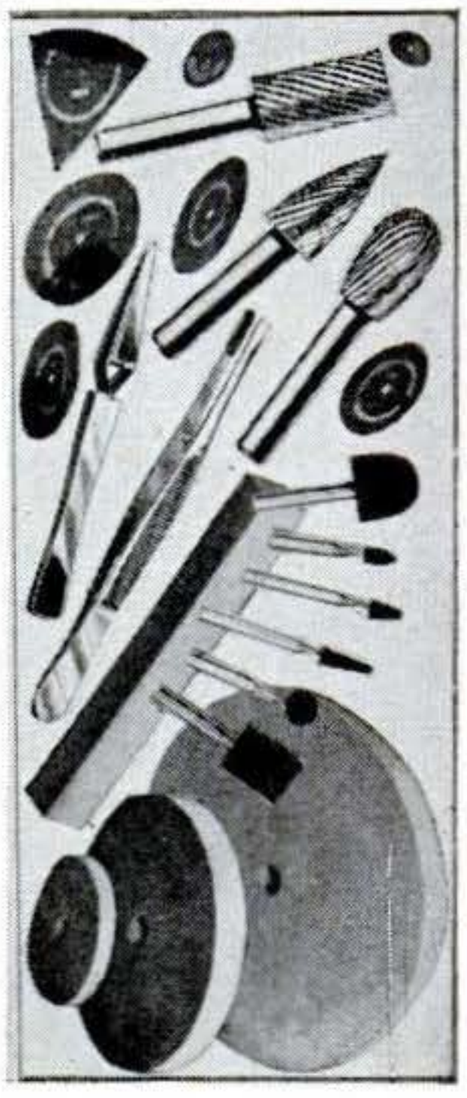

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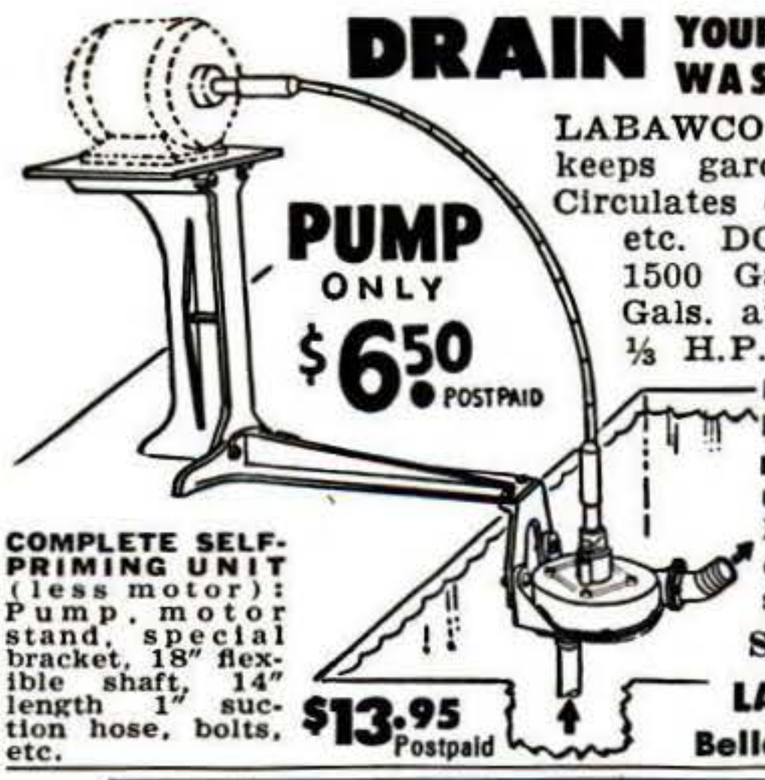

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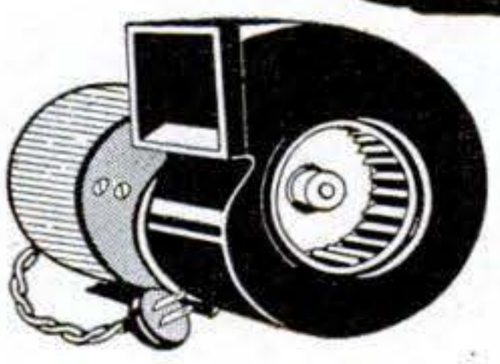

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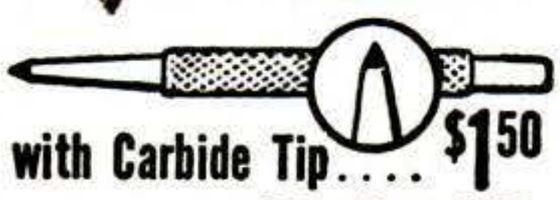

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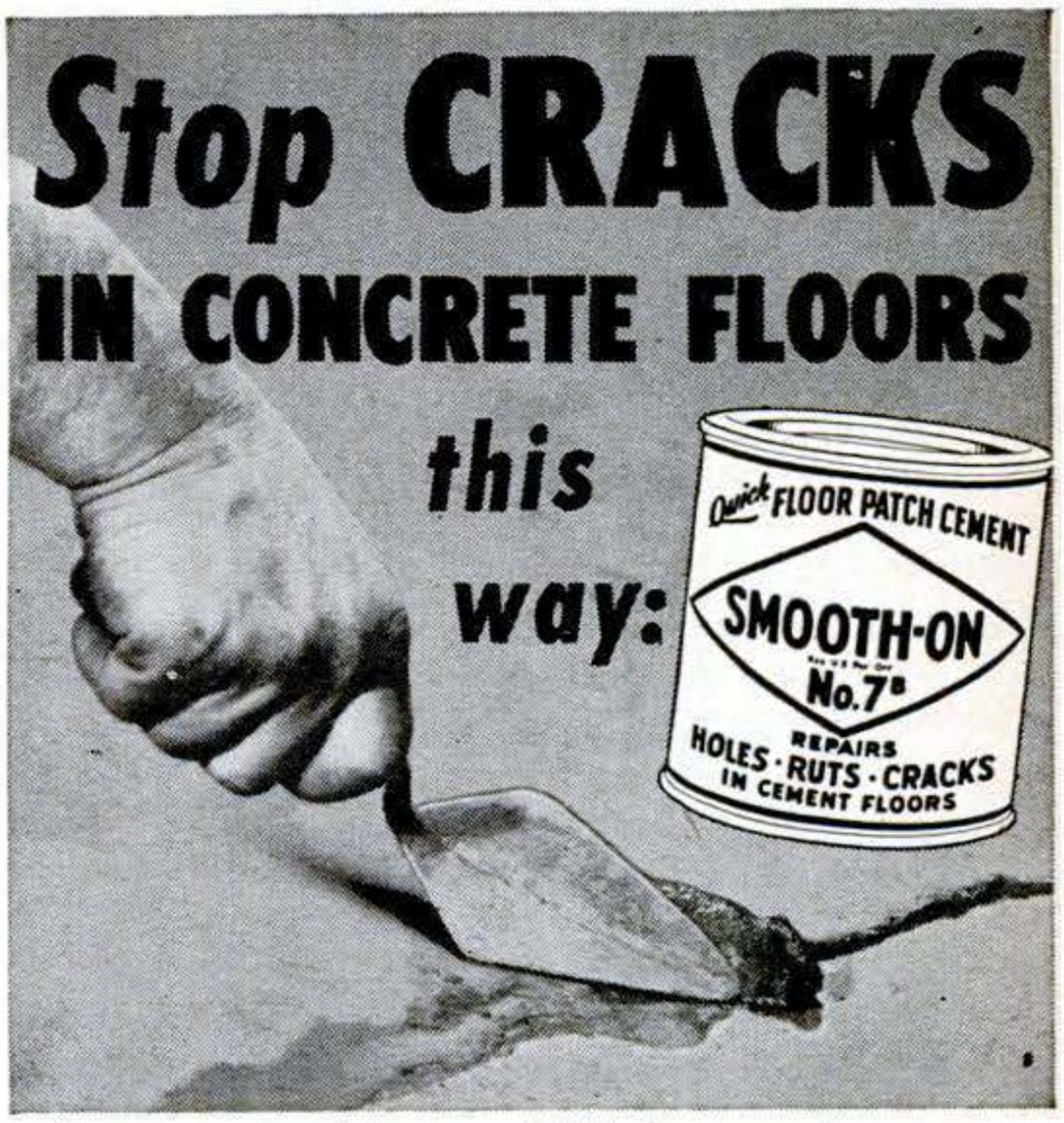

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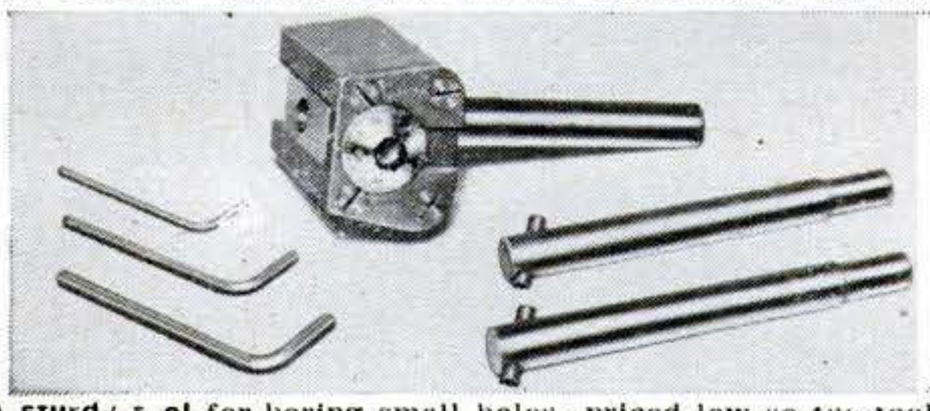

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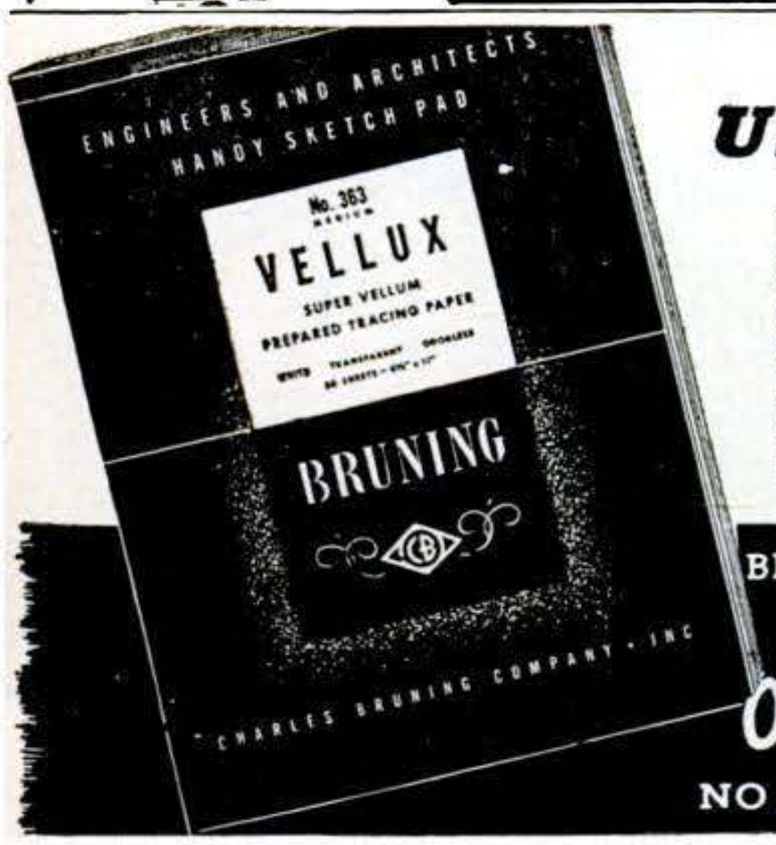

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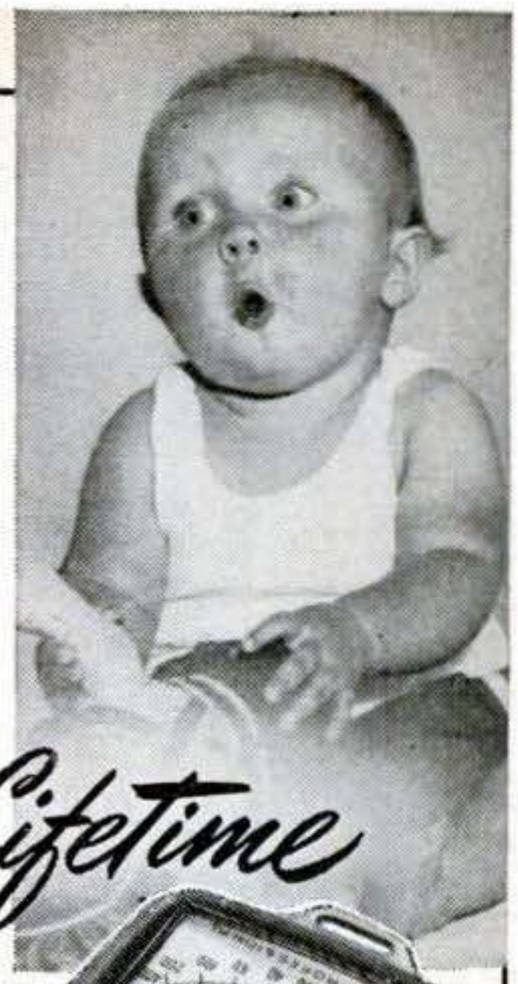

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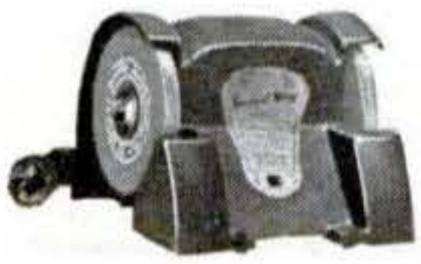

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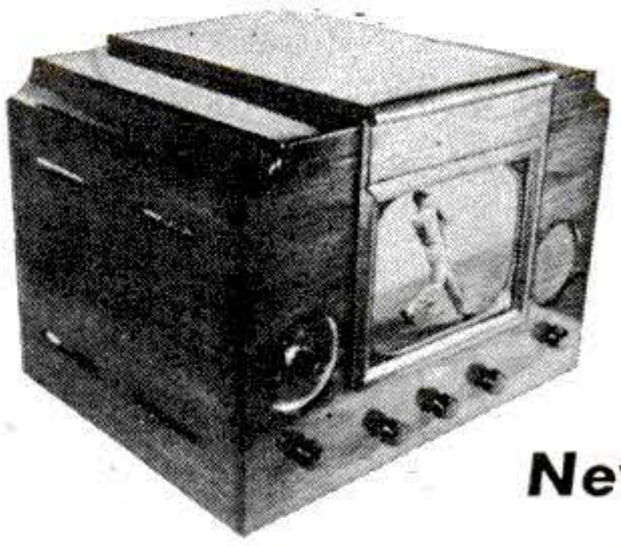

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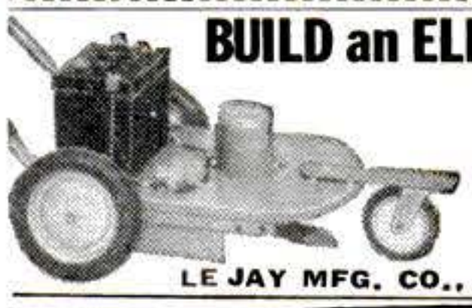

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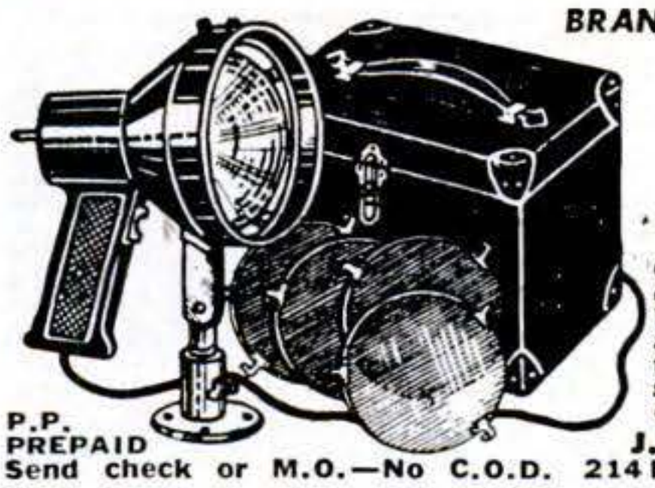

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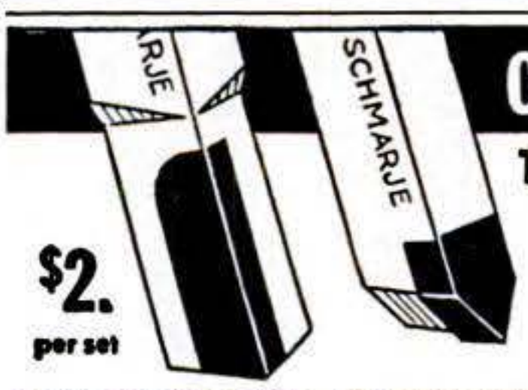

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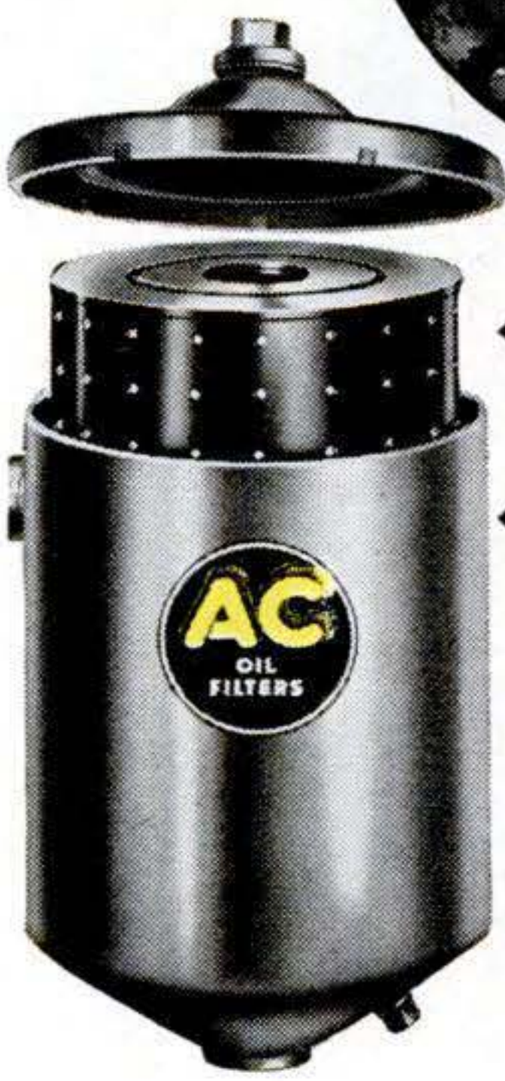

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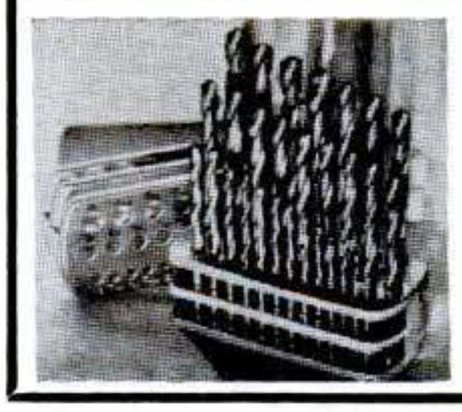

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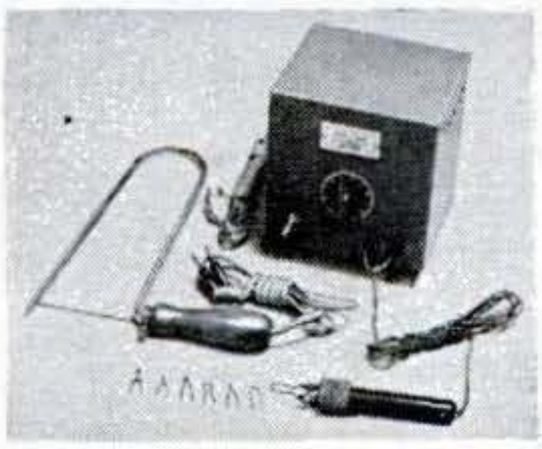

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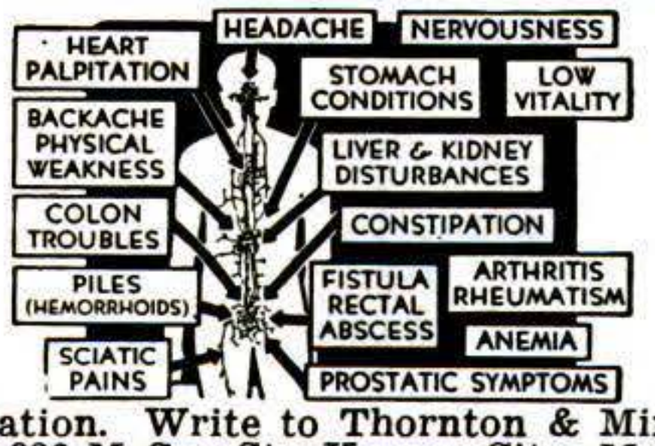

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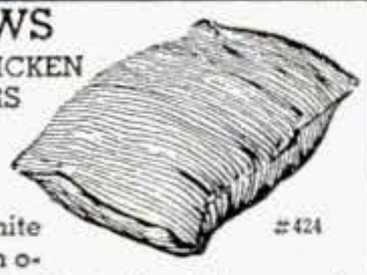

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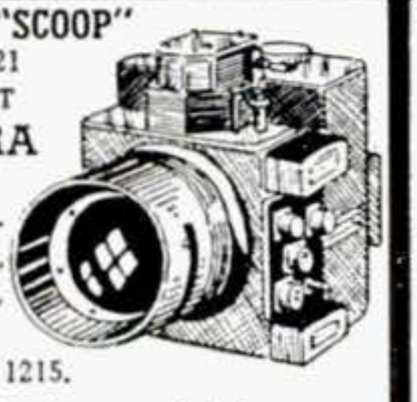

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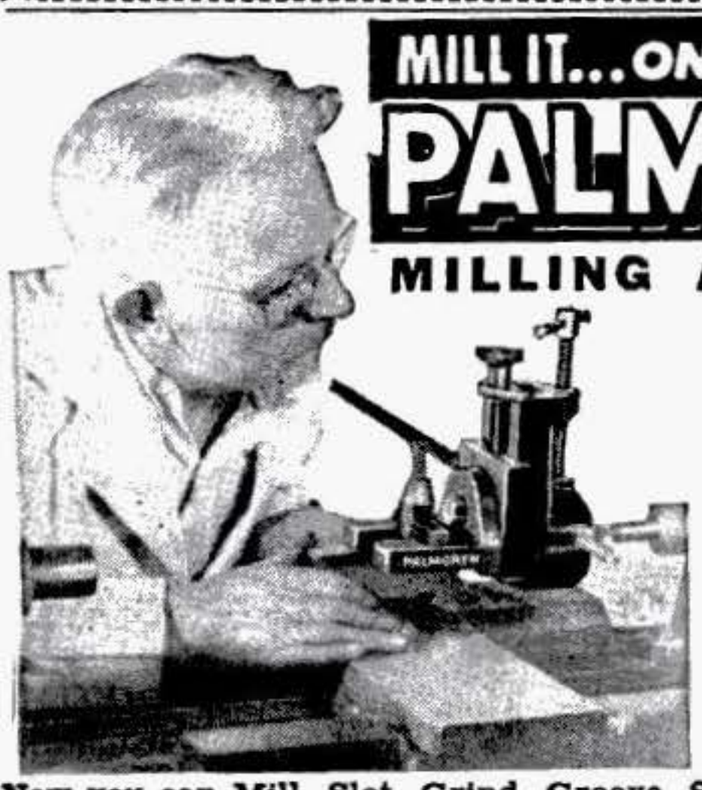

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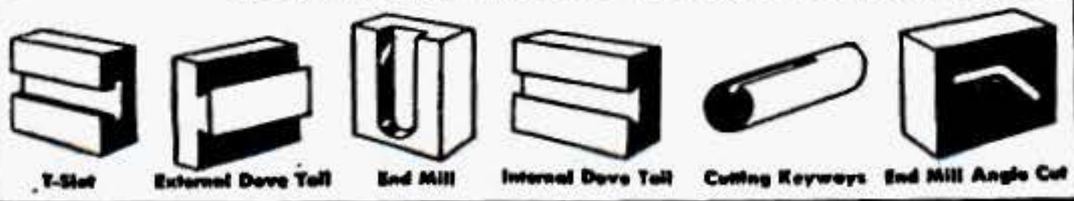

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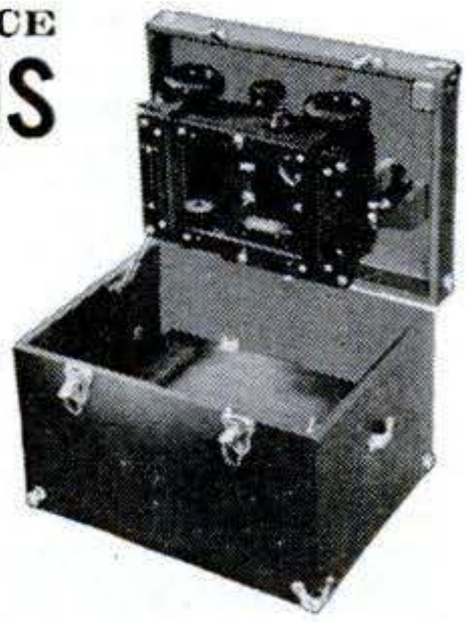

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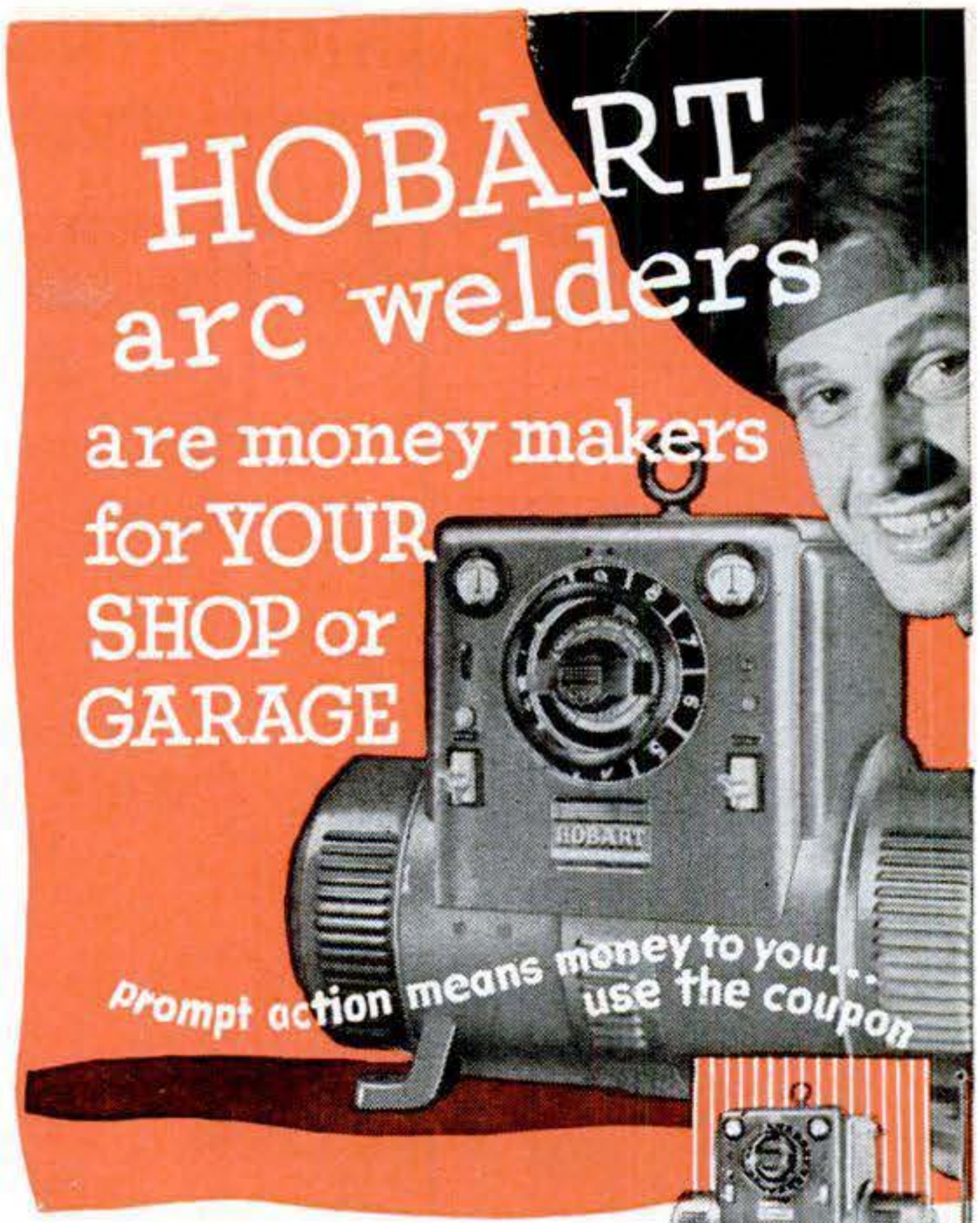

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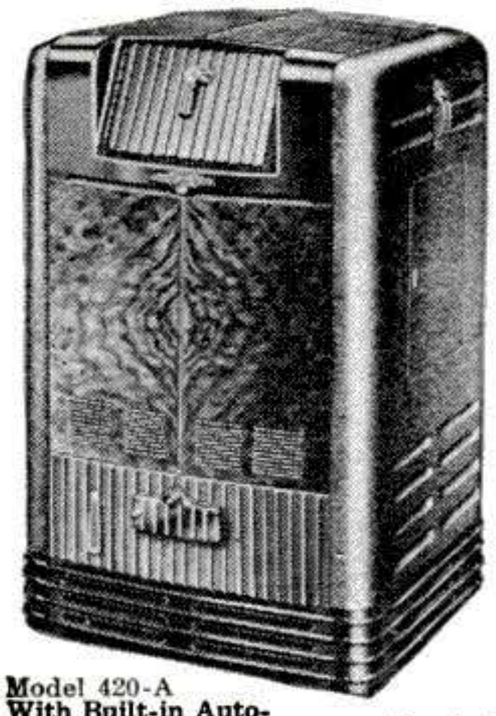

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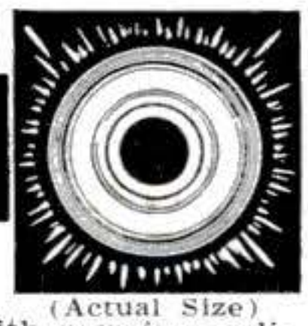

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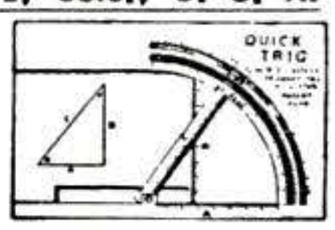

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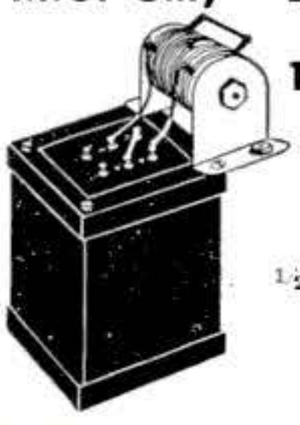

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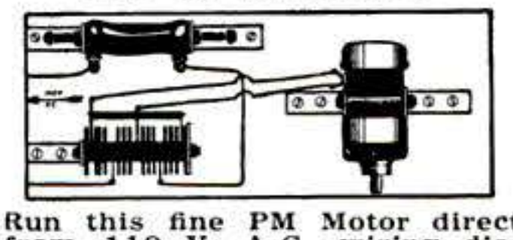

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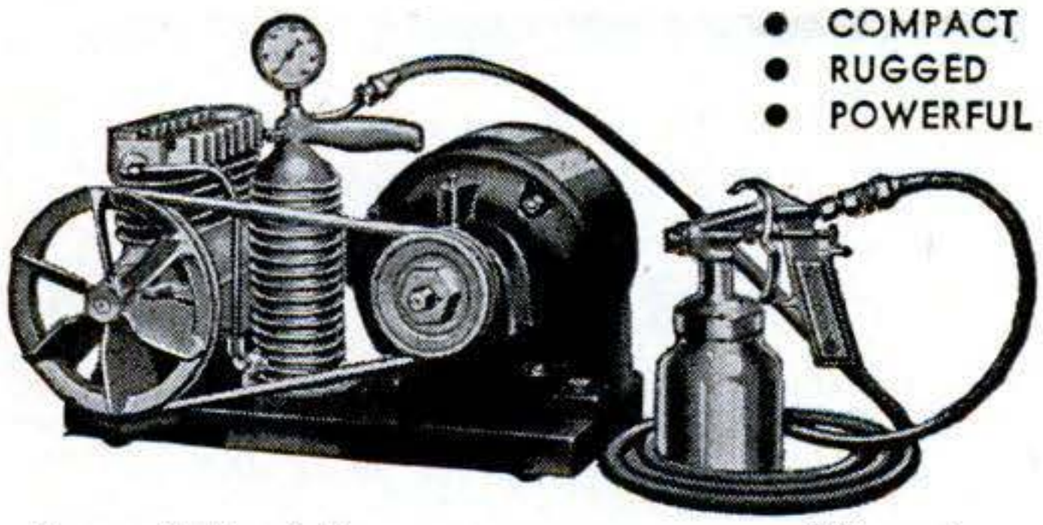

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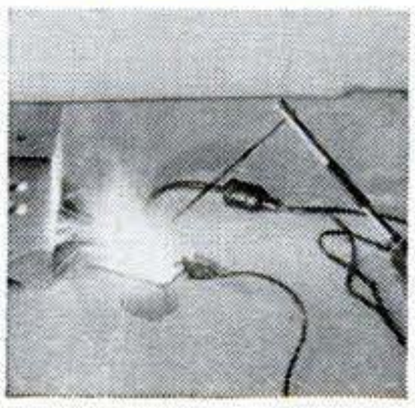

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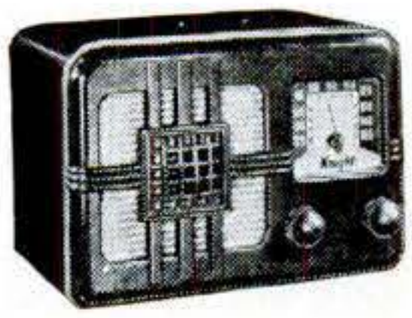

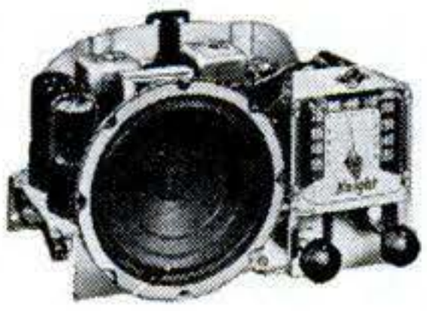

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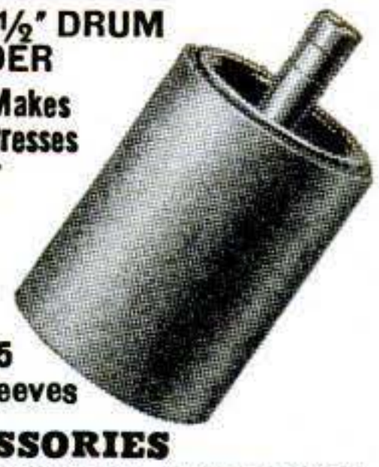

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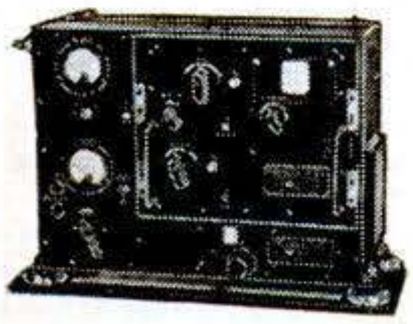

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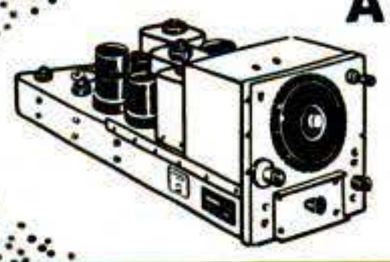

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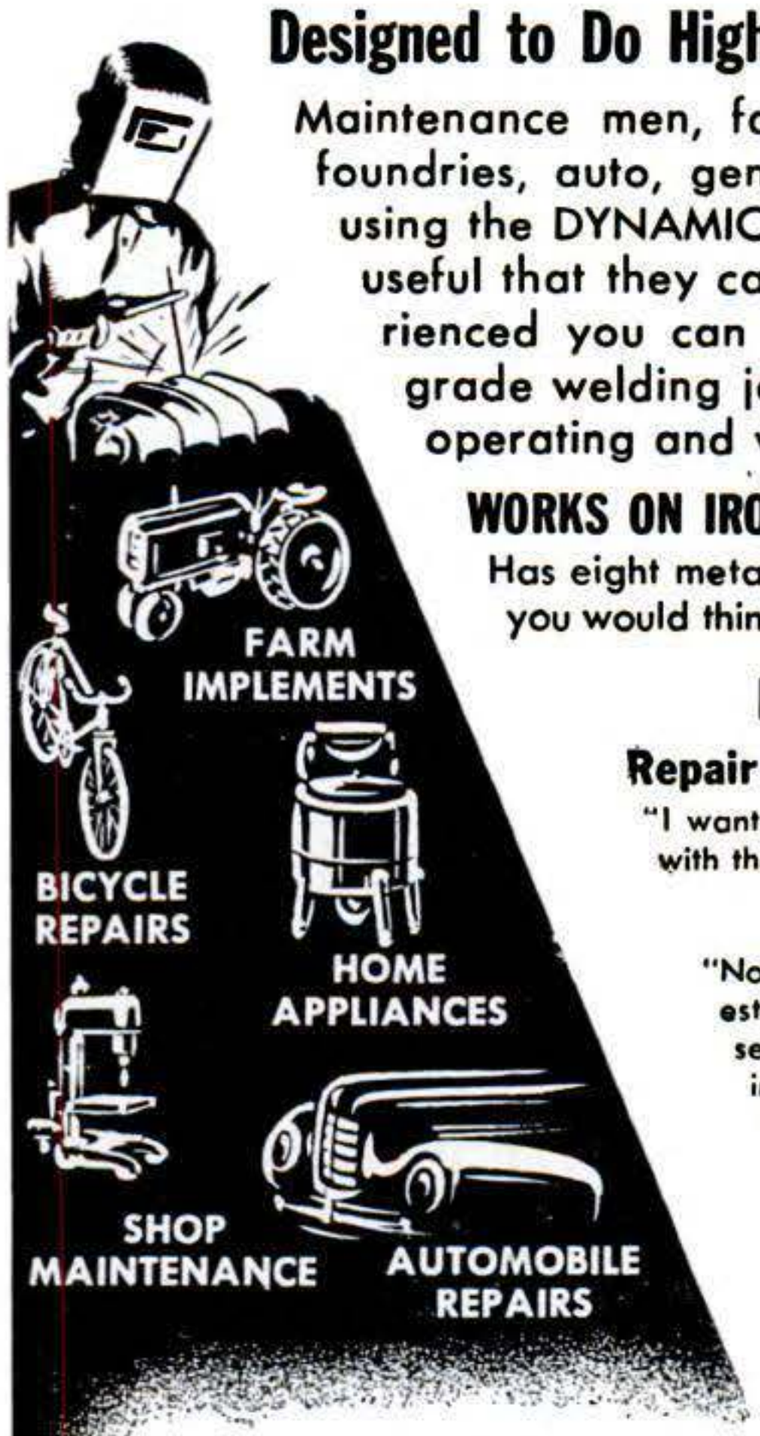

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Riding above train level, passengers in Vista-Dome car get wide view of sky and countryside.

TO: Reader
FROM: Editor

Dreaming in Steel

ONE of the functions of PSM is to report the dreams of science and industry: the little gimmick which prevents a cut thumb on an otherwise temporarily happy housewife; the multipowered whosis which will whisk a camera off the planet; and everything in between.

Usually, those of us who see the sketches, talk to the inventors, or draw the cross-sections rarely get to risk the thumb or ride in the interplanetary rockets. So it is with special satisfaction that I tell you about my ride in one dream that came true.

This particular dream was about a new kind of railroad car. The Budd people called it the "Vista-Dome Car." You saw it pictured in PSM before it was made, and you saw how it was made. I saw it dreamed up complete in stainless steel but standing still, and decided it was a handsome day coach with a sun porch; an impressive but not important penthouse on wheels; an amusing but hardly vital new model for the old chore of hauling people around on the ground.

I was wrong. And I suspect a lot of old railroad men who have only seen the pictures are also wrong when they discuss this steel dream as an expensive concession to publicity and passengers on the part of the good old freight that brings in the money.

Because these new cars offer a new kind of railroad travel, bring a new excitement to any old train trip. Riding in the conventional car, you see only what is on one side of the track, and what is below the level of your eye and the window. In the upper seats of a Vista-Dome car, you see both sides of the tracks, what's above you, and what's ahead and behind. It's like flying—but lower and closer to the scenery than most pilots would care to go. It's like riding in an open car without feeling wind, rain or sun; without the noise.

Over your head, steel frames give a sense of safety. Double layers of glass filter glare and heat. Insulation and air conditioning cut outside sound to a murmur. There's no roar and click of wheels on rails. Even a passing locomotive, visually furious with smoke and steam, can hardly be heard.

I have seen a lot of this country through the windshield of an automobile, through the slots of day coach and Pullman windows, through the holes in the clouds from an airplane. But I wish I could see America first through a Vista-Dome.

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Our coach forgot a rule!

"YOU GOTTA KNOW ALL THE RULES," I reminded our high school coach the other day, "if you expect your team to win."

"It's the same way with your car," I said, "from the way it looks and runs, you're playing a losing game."

When he asked what I meant, I told him, "You call me your Doctor of Motors and expect me to make sure that your car gives you trouble-free, economical transportation. If you make it a rule to come in regularly, I can spot little troubles before they get big and costly."

Well, I fixed his car—ground the valves, replaced the gaskets, put in Perfect Circle Piston Rings to stop her oil pumping, tuned her up—and from the way he smiled you could tell he felt like he had another winner.

Then, he agreed that it was just plain common sense to bring his car in for regular checkups—that he would make it his No. 1 car rule and never forget it again.

NOTICE TO CAR OWNERS. Perfect Circles are available at any automotive repair shop. Your favorite mechanic—your Doctor of Motors—recommends them. Perfect Circle Corporation, Hagerstown, Indiana, U. S. A. The Perfect Circle Company, Ltd., Toronto, Ontario, Canada.

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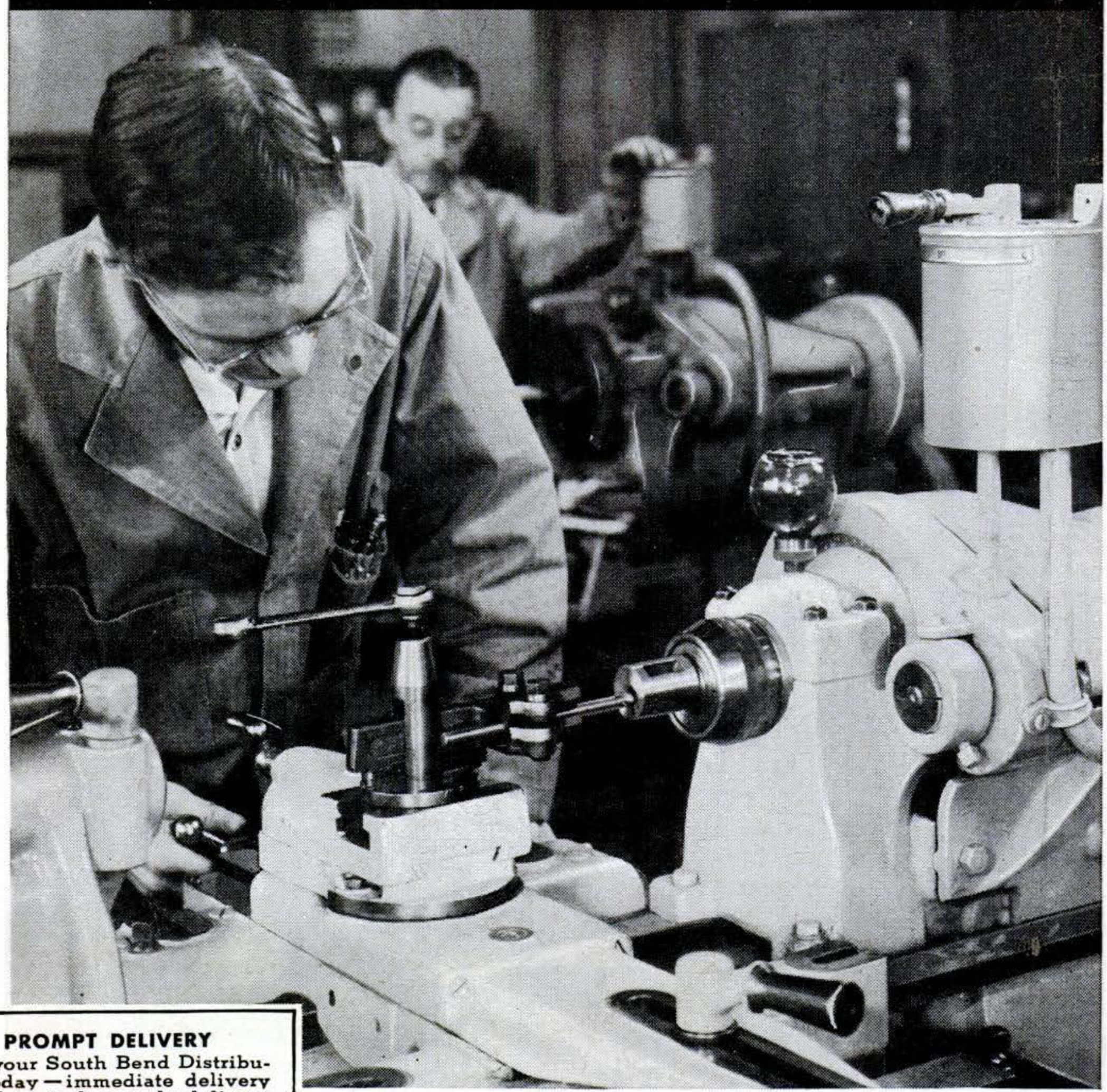

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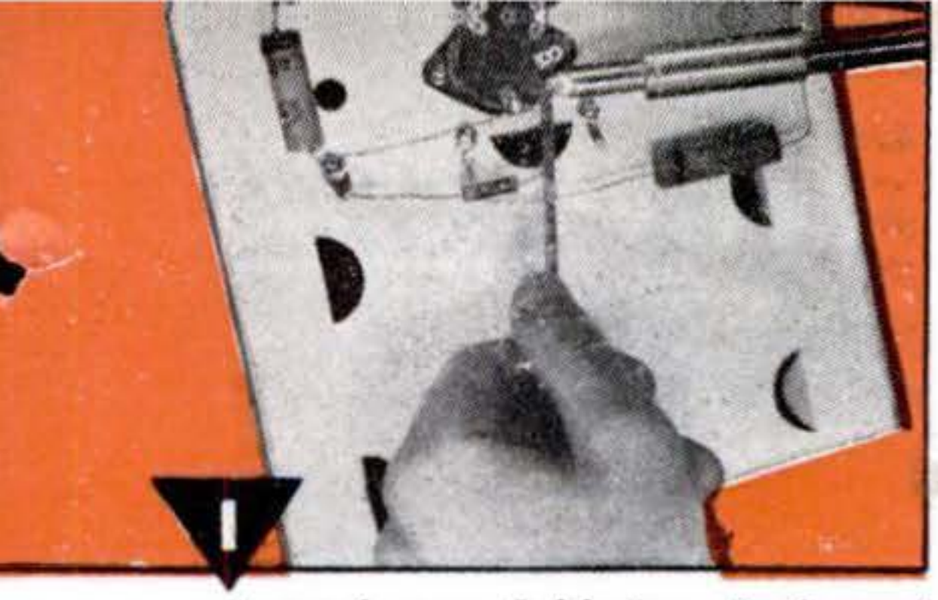

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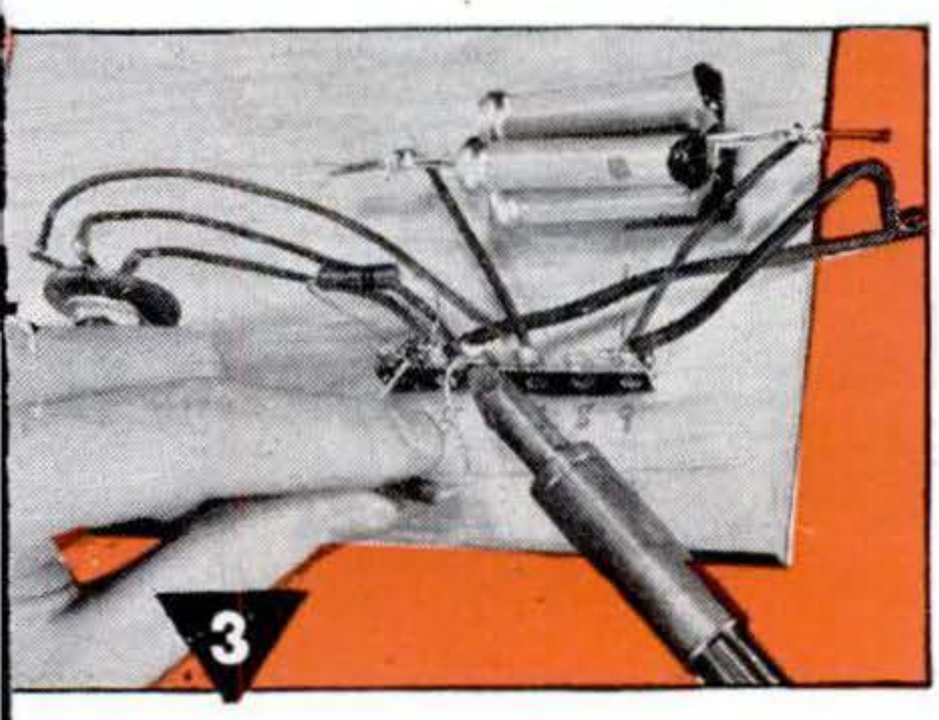

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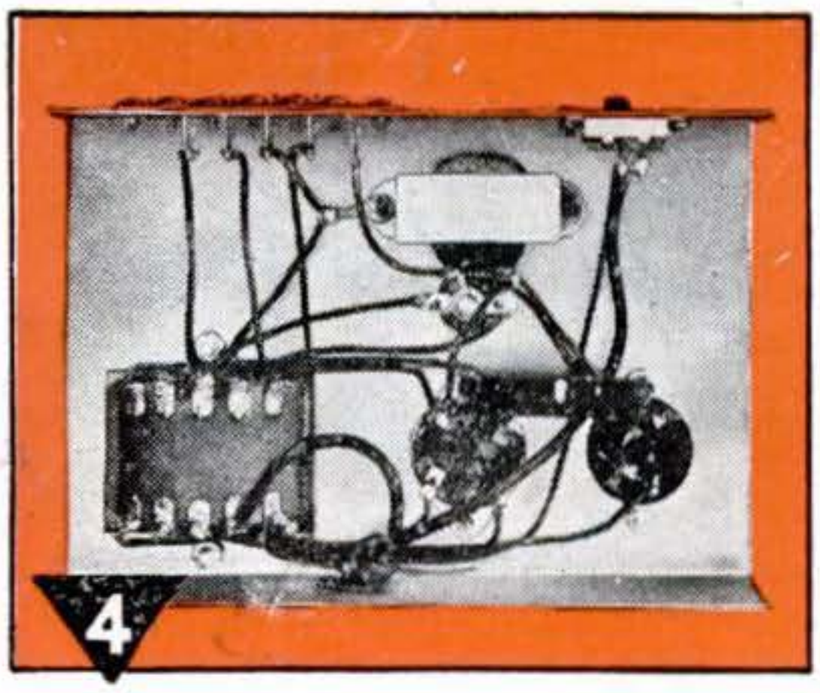
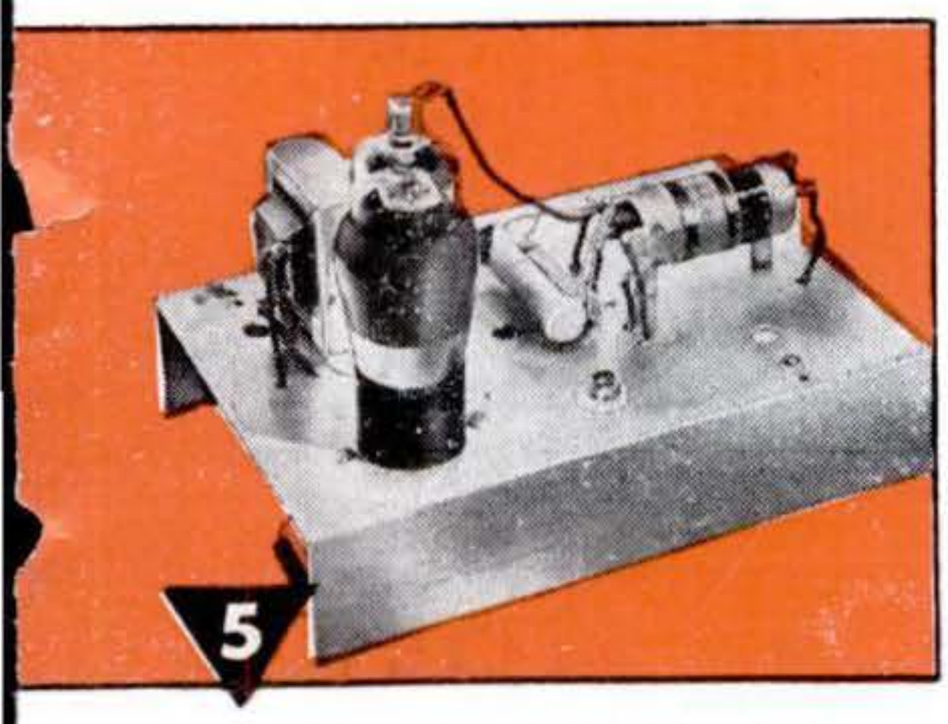


You get parts to build this Vacuum Tube Power Pack, make changes which give you experience with packs of many kinds; learn to correct power pack troubles.



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